Fisheries and Oceans Canada | Pêches et Océans Canada

Science | Sciences

CSAS | **SCCS**

Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Proceedings Series 2006/047 | **Série des comptes rendus 2006/047**

Presentation and Review of the Benthic Mapping Project in Scallop Fishing Area 29, Southwest Nova Scotia

16 February 2006
Holiday Inn Harbourview
Dartmouth, Nova Scotia

Stephen J. Smith

Dept. Fisheries and Oceans
Population Ecology Division
Bedford Institute of Oceanography
1 Challenger Drive, P.O. Box 1006
Dartmouth, Nova Scotia B2Y 4A2

March 2007

Présentation et examen du projet de cartes benthiques dans la zone de pêche du pétoncle 29, au sud-ouest de la Nouvelle-Écosse

Le 16 février 2006
Holiday Inn Harbourview
Dartmouth (Nouvelle-Écosse)

Stephen J. Smith

Pêches et Océans
Division de l'écologie des populations
Institut océanographique de Bedford
1 Challenger Drive, C.P. 1006
Darrmouth (Nouvelle-Écosse) B2Y 4A2

mars 2007

Canadä

FOREWORD

The purpose of these proceedings is to archive the activities and discussions of the meeting, including research recommendations, uncertainties, and to provide a place to formally archive official minority opinions. As such, interpretations and opinions presented in this report may be factually incorrect or misleading, but are included to record as faithfully as possible what transpired at the meeting. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement had been reached.

AVANT-PROPOS

Le présent compte rendu fait état des activités et des discussions qui ont eu lieu à la réunion, notamment en ce qui concerne les recommandations de recherche et les incertitudes; il sert aussi à consigner en bonne et due forme les opinions minoritaires officielles. Les interprétations et opinions qui y sont présentées peuvent être incorrectes sur le plan des faits ou trompeuses, mais elles sont intégrées au document pour que celui-ci reflète le plus fidèlement possible ce qui s'est dit à la réunion. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s'il est clairement indiqué qu'elle l'est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire.

Presentation and Review of the Benthic Mapping Project in Scallop Fishing Area 29, Southwest Nova Scotia

16 February 2006
Holiday Inn Harbourview
Dartmouth, Nova Scotia

Stephen J. Smith

Dept. Fisheries and Oceans
Population Ecology Division
Bedford Institute of Oceanography
1 Challenger Drive, P.O. Box 1006
Dartmouth, Nova Scotia B2Y 4A2

March 2007

Présentation et examen du projet de cartes benthiques dans la zone de pêche du pétoncle 29, au sud-ouest de la Nouvelle-Écosse

Le 16 février 2006
Holiday Inn Harbourview
Dartmouth (Nouvelle-Écosse)

Stephen J. Smith

Pêches et Océans
Division de l'écologie des populations
Institut océanographique de Bedford
1 Challenger Drive, C.P. 1006
Darrmouth (Nouvelle-Écosse) B2Y 4A2

mars 2007

ISSN 1701-1272 (Printed / Imprimé)

Published and available free from:
Une publication gratuite de :

Fisheries and Oceans Canada / Pêches et Océans Canada
Canadian Science Advisory Secretariat / Secrétariat canadien de consultation scientifique
200, rue Kent Street
Ottawa, Ontario
K1A 0E6

http://www.dfo-mpo.gc.ca/csas/

CSAS@DFO-MPO.GC.CA

Printed on recycled paper.
Imprimé sur papier recyclé.

Correct citation for this publication:
On doit citer cette publication comme suit :

DFO, 2006. Presentation and Review of the Benthic Mapping Project in Scallop Fishing Area 29, Southwest Nova Scotia; 16 February 2006. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2006/047.

TABLE OF CONTENTS

SUMMARY

The sea scallop scallop (*Placopecten magellanicus*) fishery in Southwest Nova Scotia in Scallop Fishing Area 29 is unique in a number of ways. This new fishery has had full monitoring in terms of annual surveys, observer coverage, catch sampling and satellite monitoring systems since it began in 2001. In 2002, a three-year joint project agreement was signed with the fishing fleets, Natural Resources Canada, and Department of Fisheries and Oceans with all parties providing funds to conduct multibeam sonar acoustic mapping of the sea floor and for associated scientific work. Maps of high-resolution bathymetry, acoustic backscatter strength and surficial geology have been produced from this project. In addition, benthic data were collected using photographic and video equipment for the analysis of the distribution of benthic assemblages in relation to bottom type.

A one-day workshop was held on February 16, 2006 in Dartmouth, Nova Scotia to present results to date from this project. In attendance were researchers, members of the fishing industry and fisheries managers who were interested in these data and associated analyses. After a review of the data collected in the project, progress in four areas of research was highlighted. Based upon video and data from the observer program, seas scallops were found in most areas but were most abundant on flat gravel lag and stable sands. Restricting dragging for scallops on the flat gravel lag or in sand could improve catches, minimize gear losses and greatly reduce bycatch and damage to epibenthic communities, which are the most abundant on bedrock outcrops and till. The bathymetry maps were used in the last three years for planning survey tows and as a result greatly reduced gear damage during the annual survey. The 2005 survey was redesigned using the surficial maps and preliminary results indicated that this new design resulted in more precise estimates of biomass. Finally, the commercial catch per unit effort was analysed using the surficial geology maps and the results suggested that current catch rates are being maintained by moving to previously unfished areas.

Discussion after the presentations focussed on everything from availability of the data to using these kinds of data to manage fisheries. Overall, the fishing industry representatives were positive about the results but would have preferred to have more control over their participation. Access to fishing in this area was conditional on the fishermen contributing to funding the project.

SOMMAIRE

La pêche du pétoncle géant (*Placopecten magellanicus*) dans la zone de pêche du pétoncle 29, située dans le sud-ouest de la Nouvelle-Écosse, est unique à bien des égards. Depuis ses débuts, en 2001, cette nouvelle pêche a fait l'objet d'une surveillance totale sous forme de relevés annuels, de la présence d'observateurs, d'échantillonnage des prises et de surveillance par satellite. En 2002, une entente triennale de projet conjoint a été conclue entre les flottilles de pêche, Ressources naturelles Canada et le ministère des Pêches et des Océans, prévoyant que chacune des parties contribue financièrement à l'exécution de relevés acoustiques multifaisceaux en vue de l'établissement de cartes du fond marin et aux travaux scientifiques connexes. L'entente a abouti à l'établissement de cartes bathymétriques à haute résolution, de cartes de l'intensité de la rétrodiffusion du signal acoustique et de cartes géologiques des dépôts meubles. Des données benthiques ont également été recueillies à l'aide d'appareils vidéo et d'appareils photographiques dans le but d'analyser la répartition des assemblages benthiques par rapport au type de fond.

Un atelier d'une journée a eu lieu le 16 février 2006 à Dartmouth (Nouvelle-Écosse) pour présenter les résultats obtenus jusqu'ici dans le cadre de ce projet. Y assistaient des chercheurs, des membres de l'industrie de la pêche et des gestionnaires des pêches intéressés par ces données et par les analyses connexes. Après un examen des données recueillies dans le projet, on a présenté les progrès réalisés dans quatre domaines de recherche. Les images vidéo et les données des observateurs révèlent que des pétoncles géants étaient présents presque partout, mais qu'ils étaient plus abondants sur les fonds plats de dépôts résiduels de gravier et les fonds sablonneux stables. En limitant la pêche du pétoncle à la drague aux fonds plats des dépôts résiduels ou aux fonds sablonneux, on pourrait peut-être accroître les prises, réduire les pertes d'engins et réduire fortement les prises accessoires et les dommages parmi les communautés épibenthiques, qui abondent surtout sur les affleurements rocheux et le till. Au cours des trois dernières années, les cartes bathymétriques ont servi à la planification des traits de relevé, ce qui a permis de réduire de beaucoup les dommages aux engins durant le relevé annuel. Le plan de relevé de 2005 a été modifié au regard des cartes géologiques des dépôts meubles, et les résultats préliminaires indiquent que le nouveau plan de relevé a donné des estimations plus précises de la biomasse. Enfin, les prises commerciales par unité d'effort ont été analysées en fonction des cartes géologiques des dépôts meubles, et les résultats donnent à penser que les pêcheurs réussissent à maintenir les taux de capture actuels en allant pêcher dans des zones inexploitées jusqu'à maintenant.

Les discussions qui ont suivi les exposés ont porté sur une variété de sujets, allant de la disponibilité de ce type de données à leur utilisation dans la gestion des pêches. Dans l'ensemble, les représentants de l'industrie de la pêche étaient satisfaits des résultats du projet, mais ils auraient souhaité avoir plus de contrôle sur leur participation. L'accès à la pêche dans cette zone était conditionnelle à la contribution des pêcheurs au financement du projet.

I. INTRODUCTION

S. J. Smith[1] and R.A. Pickrill[2]

[1]Population Ecology Division
Department of Fisheries and Oceans
[2]Geological Survey of Canada (Atlantic),
Natural Resources Canada,
Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia, B2Y 4A2, Canada

Scallop Fishing Area (SFA) 29 encompasses a very large inshore area inside the 12-mile territorial sea, from the south of Yarmouth (latitude 43°40'N) to Cape North in Cape Breton. This report refers to only that portion of SFA 29 west of longitude 65°30'W continuing north to SPA 3 at latitude 43°40'N (Figure 1).

Prior to 1986, the Full Bay Scallop fleet had fished in this area. Following the 1986 inshore/offshore scallop fishing agreement, fishing by the Full Bay fleet was restricted to north of latitude 43°40'N. A limited fishery by the Full Bay fleet was granted from 1996–98 (More details on history given in Smith and Lundy 2002). Access was again granted to this fleet in 2001 with a full at-sea monitoring program, and with a condition of a post-season industry-funded survey. Scallop fishers had consulted with lobster fishers in the area to deal with potential conflicts. Lobster by-catch was minimal in 2001 despite high scallop catch rates. Lobster bycatch continues to be monitored in this fishery. In 2002, the Minister approved access to this area by the Full Bay fleet and inshore east of Baccaro licence holders who are authorized to fish in SFA 29 west of longitude 65°30'W. SFA 29 inshore scallop licenses were historically restricted to east of Baccaro (east of longitude 65°30'W).

A three year joint project agreement was signed in 2002 with the fishing fleets, Natural Resources Canada, and Department of Fisheries and Oceans with all parties providing funds to the project. The main products of the project from the government agencies were to collect multibeam data and produce fine scale bathymetry and backscatter maps, to conduct geological sampling and produce surficial geology maps. In the offshore scallop fishery these maps have proven to be useful in identifying scallop habitat. The annual research surveys of the resource were continued, and are being integrated with the terrain mapping to produce habitat maps.

The actual contributions are presented in detail elsewhere in this report but we note here that in addition to the contribution of $385,000 (CAD) over three years, the fishing industry also funded the catch sampling program, onboard observers and the satellite vessel monitoring (VMS) costs with respect to equipment on the boats and associated operating costs.

The data collection phase of the joint project agreement has been completed and a number of products are available. Electronic and printed versions of bathymetry and backscatter maps were supplied to all of the partners of the agreement in 2003. Surficial geology maps both electronic and printed forms were supplied in 2004. We now have five years of survey data, observer data, catch sampling data and VMS data.

The purpose of this one day workshop was to present data collected in this project, present results of analysis and research to date and to solicit feedback from researchers, fishing

industry and other interested parties on the potential uses of these kinds of data. In particular, workshop participants were asked to respond to the following questions.

1. How can this kind of information be used to manage fisheries and other activities?

2. What other kind of information do we need?

3. Where else would this kind of information be useful?

4. Are there particular information needs by the fishing industry or other users that we have missed out on?

In addition to project participants the workshop included members of the research, policy and fishing community outside of the project. The workshop wrapped up with a brief outline of future plans.

The format of the proceedings from this workshop consists of extended abstracts from each of the presentations made. The terms of reference for this meeting are presented in Appendix 1 and the agenda is in Appendix 2. A list of participants along with contact information is in Appendix 3.

References

Smith, S.J., and M.J. Lundy. 2002. A brief history of scallop fishing in Scallop Fishing Area 29 and an evaluation of a fishery in 2002. Can. Science Advis. Sec. Res. Doc. 2002/079.

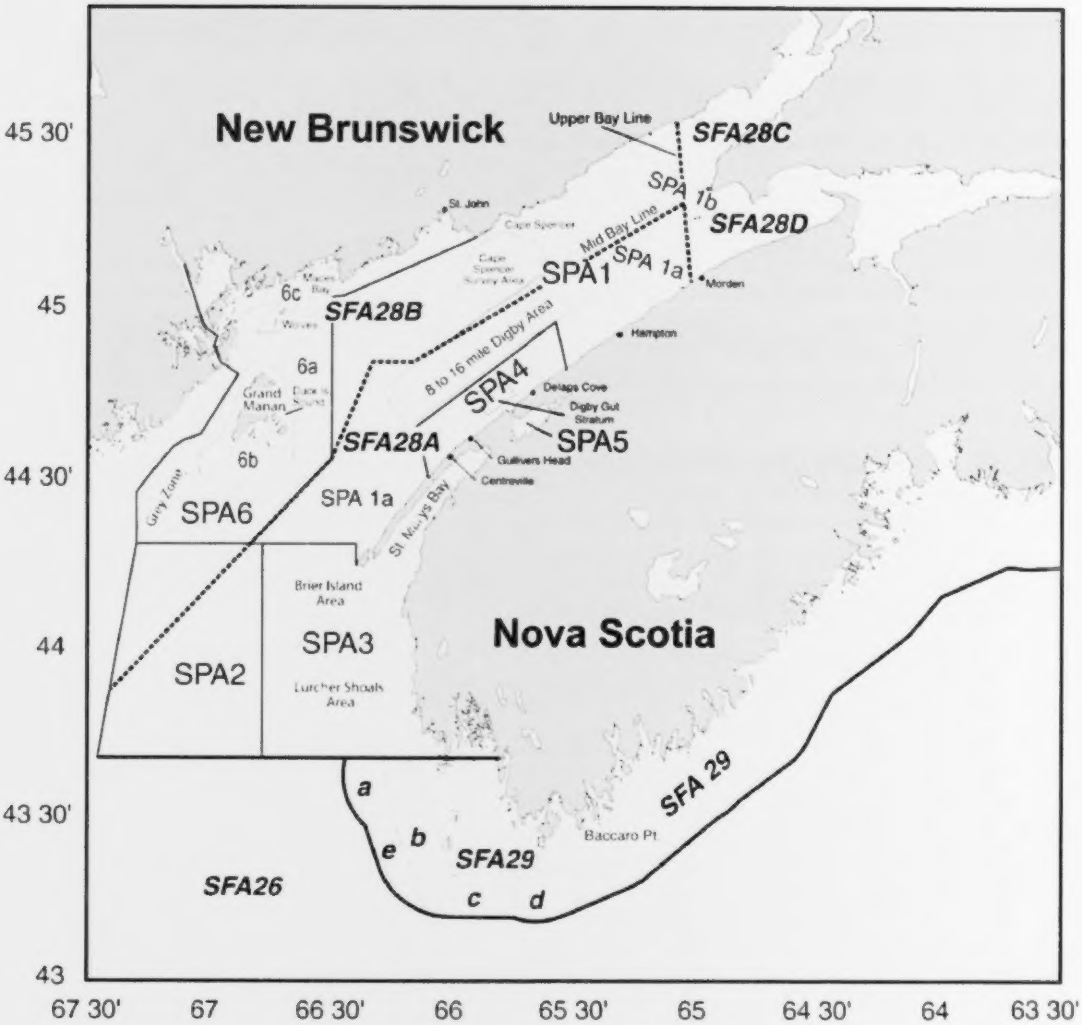

Figure 1. Scallop Fishing Area (SFA) 29 in relation to other inshore scallop fishing areas.

II. DATA COLLECTED

Seabed Mapping: Multibeam Data Collection and Map Distribution

Gerard Costello

Canadian Hydrographic Service
Department of Fisheries and Oceans
Bedford Institute of Oceanography, P.O Box 1006
Dartmouth, N.S. B2Y 4A2 Canada

The Canadian Hydrographic Service (CHS) at the Bedford Institute of Oceanography (BIO) participated in the seabed mapping component of the SFA 29 Joint Project Agreement managed by DFO Fisheries Management (Figure1). CHS responsibilities included multibeam data collection, processing, map/data production and delivery and project management. Most of these activities were shared with the Geological Survey of Canada at BIO.

Multibeam seabed mapping technology emerged in the 1980's and CHS was involved from the beginning, acquiring its first systems in 1988. The advantage of multibeam over conventional echo sounder profiles is that it provides complete seabed coverage plus high spatial resolution; i.e., multiple small acoustic footprints 'across track'. This high resolution acoustic data integrated with GPS positioning, accurate ship motion data and water column sound speed measurements provides a highly detailed seafloor image analogous to airborne remote sensing of the landmass (Figure 2).

It is important to note that most multibeam systems provide two basic data types---bathymetry giving seabed shape and backscatter strength which is a function of the seabed sediment type. Originating from the same acoustic data, both data types are 'geo-registered' and when combined with ground truth data and other geological information become a powerful dataset for understanding the seabed habitat and seafloor processes (Figure 3).

CHS have several multibeam systems installed on ships and survey launches (Figure 4). The CCGS MATTHEW and FG CREED were used to map the SFA 29 areas in southwest Nova Scotia. Data was collected on several hydrographic surveys over two years, 2002–2003. Most of areas A, B, C, D, and E were mapped covering about 1800 sq. km. (see also Fig. 1 in Smith and Pickrill 2007) and utilizing 72 days of ship time for data collection. This effort, including the ship time, multibeam systems and data processing were a significant contribution by DFO to the joint project.

As the data were collected and processed, they were delivered to the other project partners—GSC and DFO Fisheries Science for further analyses and integration with their data and to DFO Fisheries Management for distribution to the scallop fishers. In the first two years, multibeam bathymetry and backscatter maps were distributed to the scallop fishers (Figs. 5 and 6) and in the final year, surficial geology maps were distributed. Following discussions with the fishers early in the project, it was agreed to provide the maps in three formats—laminated paper maps, raster BSB and vector ASCII (lat, long, depth, backscatter strength). For the approximately 160 license holders, all received paper maps and raster images on CD and for those with '3D' electronic chart systems, the vector data was provided. Delivering the maps in formats that the fishers could install in their onboard electronic chart systems allowed them to use the data during their harvesting operations and provided them with the same data that DFO was using in managing this new scallop resource.

Acknowledgements

We thank the DFO regional office in Yarmouth, Full Bay Scallop Association, East of Baccaro scallop license holders, AEL Electronics and Marconi Electronics for their help in distributing the maps and data to the fishers. We also acknowledge the many hydrographers and ship's crew for their valuable expertise in data collection and the CHS Hydrographic Data Center for data processing and map production.

References

Smith, S.J. and R.A. Pickrill. 2007. Introduction. This volume.

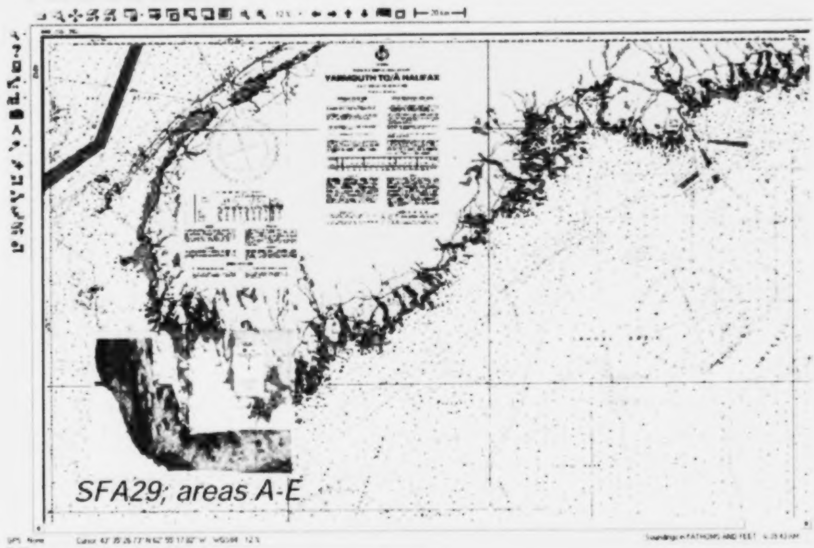

Figure 1. Scallop Fishing Area (SFA 29) indicating where multibeam mapping was completed.

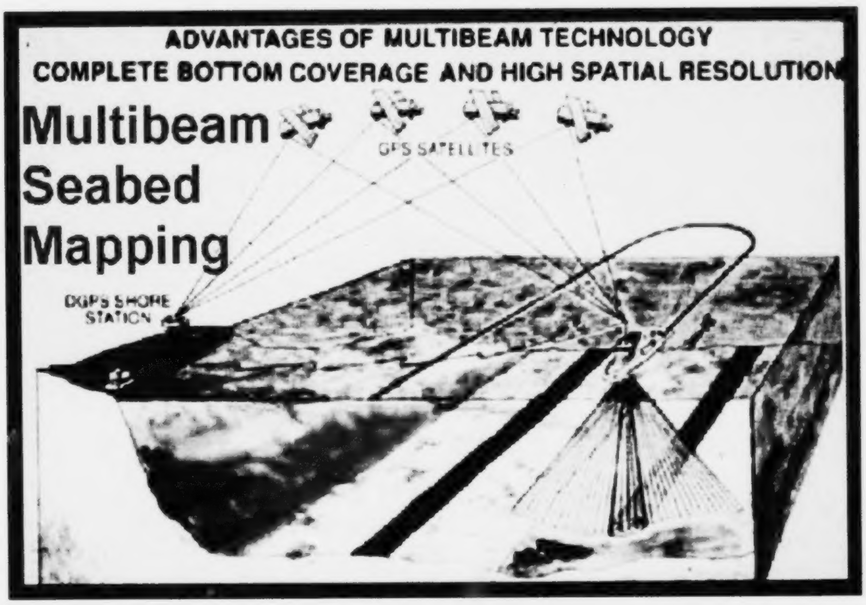

Figure 2. Multibeam coverage vs. single beam echo sounder profiles.

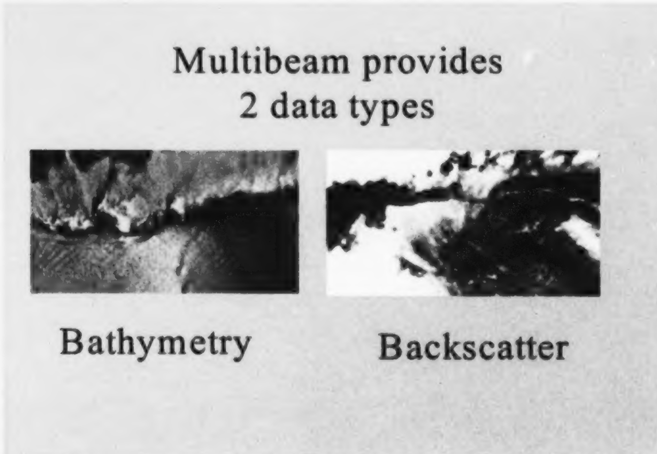

Figure 3. Multibeam data types.

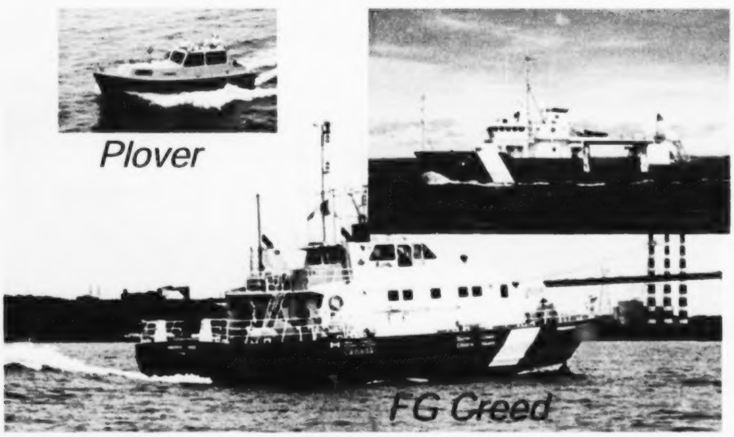

Figure 4. DFO ships with Multibeam sounders installations.

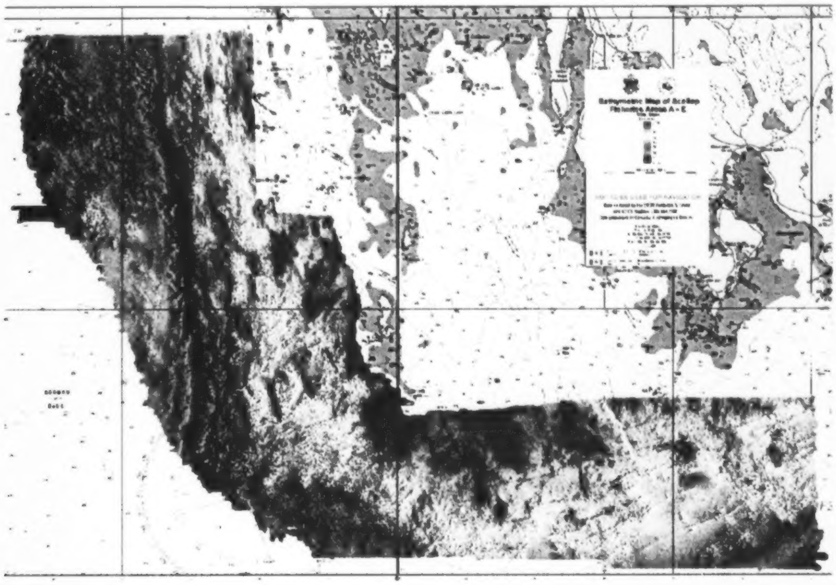

Figure 5. Multibeam bathymetric raster image; SFA 29 areas A–E.

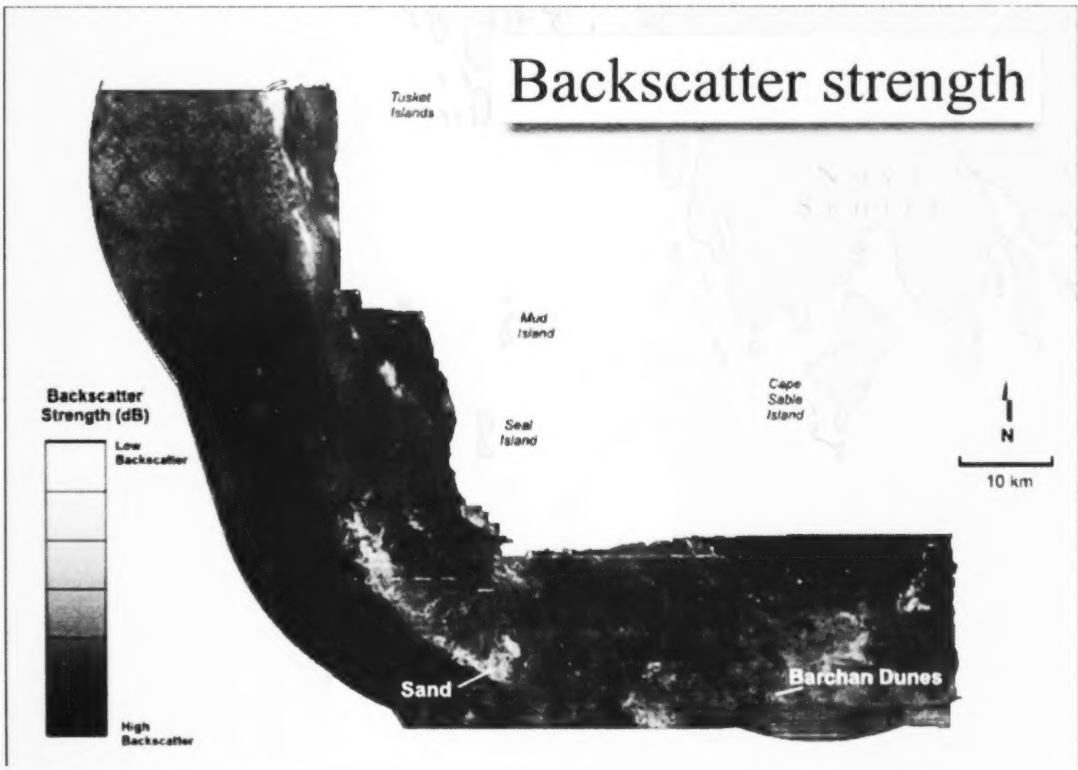

Figure 6. Multibeam Backscatter strength; SFA 29 areas A–E.

Surficial Geology of Scallop Fishing Area 29, Southwest Nova Scotia

Brian J. Todd

Geological Survey of Canada (Atlantic),
Natural Resources Canada,
Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia, B2Y 4A2, Canada

Introduction

Geoscientific surveys were carried out on Scallop Fishing Area 29 (SFA 29) to obtain groundtruth to map the surficial geology. The landforms and deposits of the sea floor of SFA 29 on German Bank provide evidence of the pattern of Late Wisconsinan deglaciation of the Gulf of Maine offshore southern Nova Scotia. The purpose of this report is to describe the surficial geological units and the glacial landforms on SFA 29 based on digital elevation models derived from multibeam sonar data augmented by geoscientific groundtruth data.

Glacial landform studies traditionally have been subaerially based, with a critical component of the mapping conducted through the interpretation of aerial photographs or satellite imagery. The horizontal resolution of such imagery is on the order of metres, thus enabling identification and interpretation of large-scale (*i.e.*, local) glacial landforms over a small-scale (*i.e.,* regional) map area. Similar regional mapping using remote sensing has not been possible in the marine environment because imagery at an equivalent resolution has not been available. Developments in multibeam sonar mapping technology, in concert with traditional marine geoscience survey techniques, now provide the capability to discriminate and locate objects on the sea floor as small as 0.5–1.0 m in size. Thus, multibeam technology now provides a subaqueous equivalent of an aerial photograph. The SFA 29 study capitalizes on this new methodology to accomplish regional mapping of local glacial landforms.

Study Area

SFA 29 is located on the Scotian Shelf off southern Nova Scotia at the entrance to the Gulf of Maine (Fig. 1). The Scotian Shelf is a formerly glaciated continental margin characterized by an inner shelf which is the offshore continuation of the prominent Maritime peneplain on the adjacent land (King & MacLean 1976). The geomorphology of the inner shelf constituting SFA 29 (Fig. 2), is dominated by outcropping bedrock consisting of Cambro–Ordovician metasedimentary rocks (Meguma Group) intruded by Late Devonian–Carboniferous granitoid plutons (Drapeau and King 197, Pe-Piper and Loncarevic 1989, Pe-Piper and Jansa 1999). Bedrock has been modified by glacial erosion and is separated from the discontinuous and thin overlying unconsolidated Quaternary sediments by a rugged erosional surface.

The now-submerged coastal plain off Nova Scotia, underlain by Cretaceous and younger sediments, was modified by the advance and retreat of North American continental ice sheets during the Quaternary Period. The last ice sheet advance culminated in the Gulf of Maine region at approximately 20 000 ^{14}C yr B.P. (20 ka); ice front retreat and glaciomarine deposition began as early as 18 ka with grounded ice absent from the Gulf of Maine by approximately 14 ka (King and Fader 1986, Schnitker *et al.* 2001).

Methods

Multibeam Sonar Bathymetry

Multibeam bathymetric data were collected over SFA 29 by the Canadian Hydrographic Service using the Canadian Coast Guard Ship *Frederick G. Creed*, a SWATH (Small Waterplane Area Twin Hull) vessel. The ship was equipped with a Simrad Subsea EM1000 multibeam bathymetric survey system (95 kHz) with the transducer mounted in the starboard pontoon. This system produces 60 beams arrayed over an arc of 150° and operates by ensonifying a narrow strip of sea floor across track and detecting the bottom echoes. The width of sea floor imaged on each survey line was five to six times the water depth. Line spacing was about three to four times water depth to provide ensonification overlap between adjacent lines. The Differential Global Positioning System was used for navigation, providing positional accuracy of ±3 m. Survey speeds averaged 14 knots resulting in an average data collection rate of about 5.0 km^2 h^{-1} in water depths of 20–70 m. The data were adjusted for tidal variation using tidal predictions from the Canadian Hydrographic Service.

The multibeam bathymetric data are presented at 5 m/pixel horizontal resolution. The shaded relief image in Figure 2 was created by vertically exaggerating the topography 10 times and then artificially illuminating the relief by a virtual light source positioned 45° above the horizon at an azimuth of 315°. In the resulting image, topographic features are enhanced by strong illumination on the northwest-facing slopes and by shadows cast on the southeast-facing slopes. Small topographic features are accentuated that could not be effectively shown by contours at this scale. Superimposed on the shaded relief image are colours assigned to water depth, ranging from white (shallow) to blue (deep). In order to apply the widest colour range to the most frequently occurring water depths, hypsometric analysis was used to calculate the cumulative frequency of water depth. The resulting colour ramp highlights subtle variations in water depth that would otherwise be obscured.

In addition to bathymetric data, multibeam sonar technology records the intensity of echoes returned from the seabed (Fig. 3). Multibeam backscatter intensity data is a measure of the reflectivity of the sea floor. High values (blue) represent hard seabeds such as rock outcrops and gravel, whereas low values (white) represent soft seabeds such as muddy sand and mud. Backscatter intensity images provide an approximation for the distribution of bottom types by emphasizing differences in acoustic response from different types of sea floor sediment.

Geoscientific Data

To complement the multibeam sonar survey, high-resolution geophysical profiles were collected in the study area (Fig. 4) (Todd *et al.* 2004). The systems deployed included a Huntec Deep Tow Seismic (DTS) boomer to show geological structure below the seabed and a Simrad MS992 sidescan sonar (120 and 330 kHz) to show the distribution and morphological details of large-scale features and bottom types.

Sea floor sediment samples were collected using a 0.75 m^3 Institutt for Kontinentalsokkel Undersøkelser (IKU) grab sampler (Fig. 4). In regions of soft sediment, the grab sampler is able to penetrate the sea floor up to 0.5 m and preserve the integrity of the layering within the surficial sediments. Grain size descriptions based on the samples adhere to the Wentworth size class scheme for clastic sediments (Wentworth 1922).

Photographic and Videographic Data

High-resolution sea floor imagery was obtained using Campod, an instrumented tripod equipped with video and still cameras (Fig. 4) (Gordon *et al.* 2000). The system included forward- and downward-looking video cameras and a downward-looking 35-mm still camera. Campod was allowed to drift across the seabed and was placed, stationary, on the sea floor at locations of interest.

Results

Exposed bedrock dominates the sea floor of SFA 29 (Fig. 5). Linear ridges of gravel, oriented southwest-northeast, are ubiquitous on the bedrock. A few of the most prominent ridges are indicated as glacial landforms (green colour) on the surficial geology map in Figure 5. The ridges are interpreted as De Geer moraines (De Geer, 1889) deposited at the termination of a tidewater ice sheet. The regional distribution of De Geer moraines indicates that the last ice front retreated to the northwest.

Patches of till occur in topographic lows on the bedrock surface. Thin (<5 m) deposits of sand are common in the southeast portion of SFA 29 but rare elsewhere. Where sand deposits do occur in small patches, the sediment sometimes takes the form of sand waves with crest lines oriented perpendicular to the dominant northwest current direction.

The northwest portion of SFA 29 is dominated by a landscape of oval mounds with long axes oriented northwest-southeast. These mounds are interpreted as drumlins formed beneath the ice sheet from till. In the topographic lows between the drumlins, post-glacial silt is deposited conformably.

Acknowledgements

Michael Lamplugh and Gerard Costello of the Canadian Hydrographic Survey (CHS) organized the multibeam sonar survey of German Bank and oversaw data processing. CHS provided the multibeam sonar data to the Geological Survey of Canada for further processing and interpretation. Kevin DesRoches (CHS) processed the multibeam sonar backscatter strength using software developed by Robert C. Courtney (Geological Survey of Canada) and archived the multibeam sonar data. I thank Fisheries and Oceans Canada for support of the survey and the masters and crews of the CCGS *Frederick G. Creed* and the CCGS *Hudson* for their efforts at sea. Geographical Information Systems and cartographic support was provided by Scott Hayward, Walli Rainey, Sheila Hynes and Phil O'Regan. Vladimir Kostylev and Robert O. Miller reviewed the report.

References

De Geer, G.F. 1889: Ändmoräner I trakten mellan Spånga och Sundbyberg. Geologiska Föreningens I Stockholm Förhandlingar 11, 395-397.

Drapeau, G., and L.H. King. 1972: Surficial geology of the Yarmouth–Browns Bank map area. Canadian Hydrographic Service, Marine Sciences Paper 2. Geological Survey of Canada Paper 72-24, 6 p.

Gordon, D.C. Jr., E.L.R. Kenchington, K.D. Gilkinson, D.L. McKeown, G. Steeves, M. Chin-Yee, W.P. Vass, K. Bentham, and P.R. Boudreau. 2000: Canadian imaging and sampling technology for studying marine benthic habitat and biological communities.

ICES 2000 Annual Science Conference, 27–30 September 2000, Bruges. ICES CM 2000/T:07

King, L.H., and G.B.J. Fader. 1986: Wisconsinan glaciation of the Atlantic continental shelf of southeast Canada. Geological Survey of Canada Bulletin 363, 72 p.

King, L.H., and B. MacLean. 1976: Geology of the Scotian Shelf. Canadian Hydrographic Service, Marine Sciences Paper 7, Geological Survey of Canada Paper 74-31, 31 p.

Pe-Piper, G., and B.D. Loncarevic. 1989: Offshore continuation of Meguma Terrane, southwestern Nova Scotia. Canadian Journal of Earth Sciences 26, 176–191.

Pe-Piper, G., and L.F. Jansa. 1999: Pre-Mesozoic rocks offshore Nova Scotia, Canada: New constraints on the accretion history of the Meguma terrane. Geological Society of America Bulletin 111, 1773–1791.

Schnitker, D., D.F. Belknap, T.S. Bacchus, J.K. Friez, B.A. Lusardi, and D.M. Popek. 2001: Deglaciation of the Gulf of Maine. *In* Weddle, T.K. & Retelle, M.J. (Eds.): Deglacial history and relative sea-level changes, northern New England and adjacent Canada. Geological Society of America Special Paper 351, 9–34.

Todd, B.J., W.A. Rainey, P.R. Girouard, P.C. Valentine, C.B. Chapman, G.D. Middleton, A.A. Boyce, M.S. Uyesugi, V.E. Kostylev, S.T. Rumbolt, S.A. Fromm, S.E. Hynes, and P.L. Spencer. 2004: Expedition report CCGS *Hudson* 2003-054: German Bank, Gulf of Maine. Geological Survey of Canada, Open File 4728, 126 p.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments. Journal of Geology, 30: 377–392.

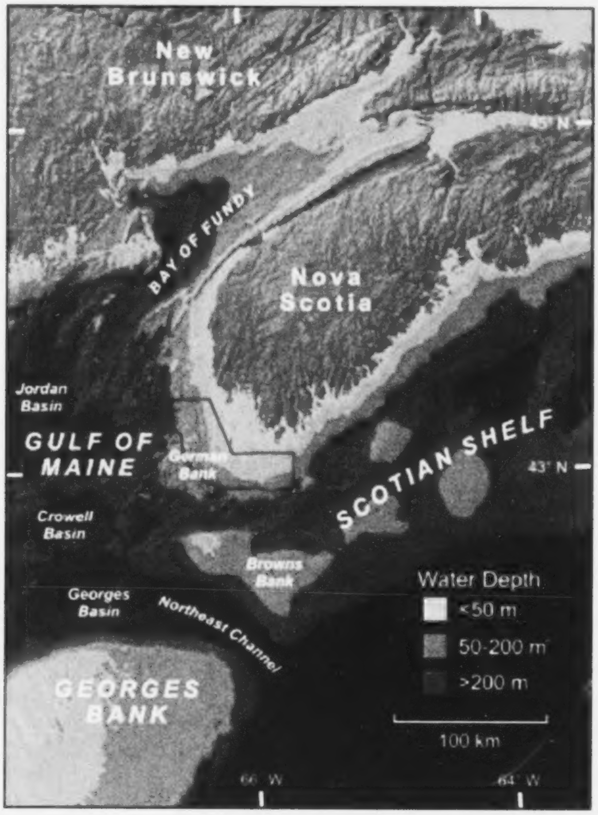

Figure 1. Location map showing the multibeam survey area of Scallop Fishing Area 29 on the south-western Scotian Shelf.

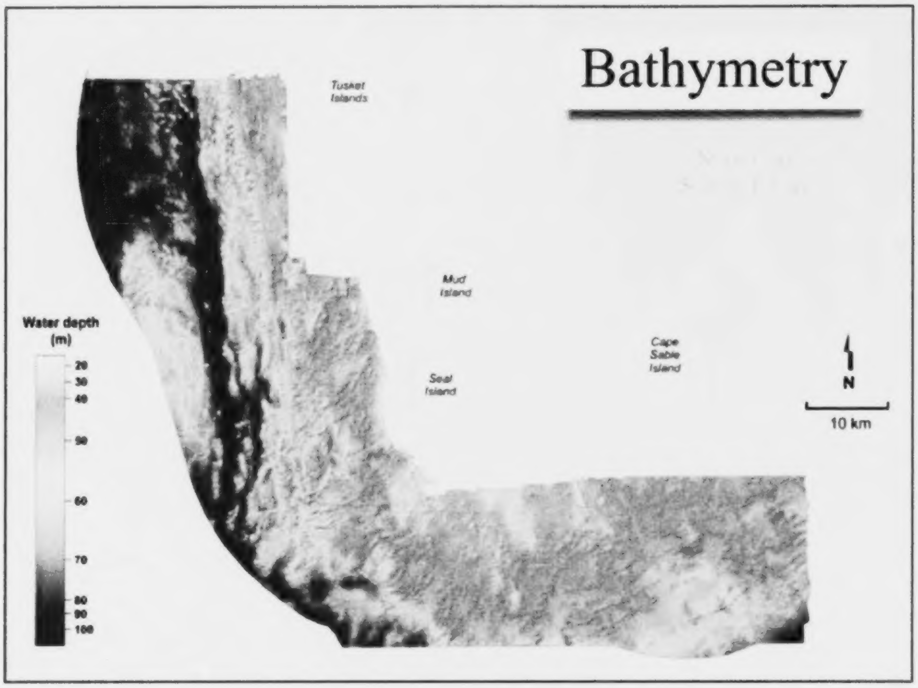

Figure 2. Seabed topography of Scallop Fishing Area 29 based on multibeam sonar mapping.

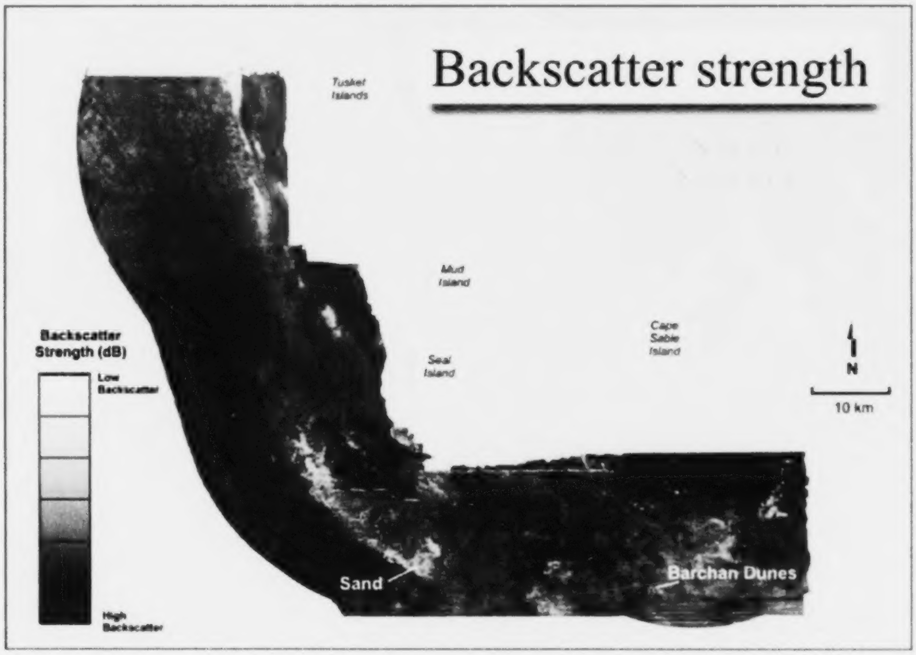

Figure 3. Backscatter strength of Scallop Fishing Area 29 based on multibeam sonar mapping.

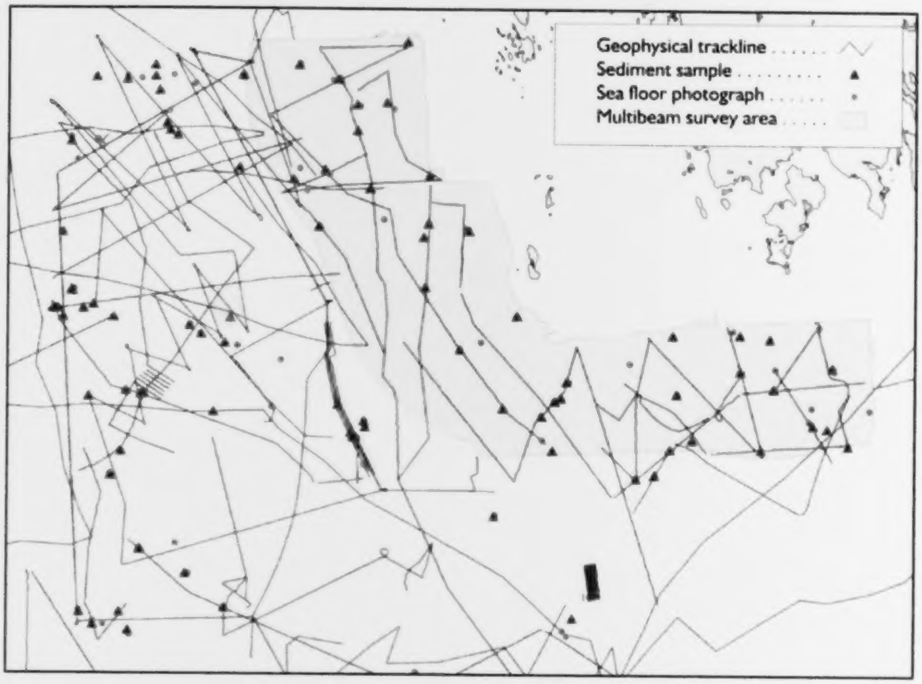

Figure 4. Location of groundtruth information on Scallop Fishing Area 29.

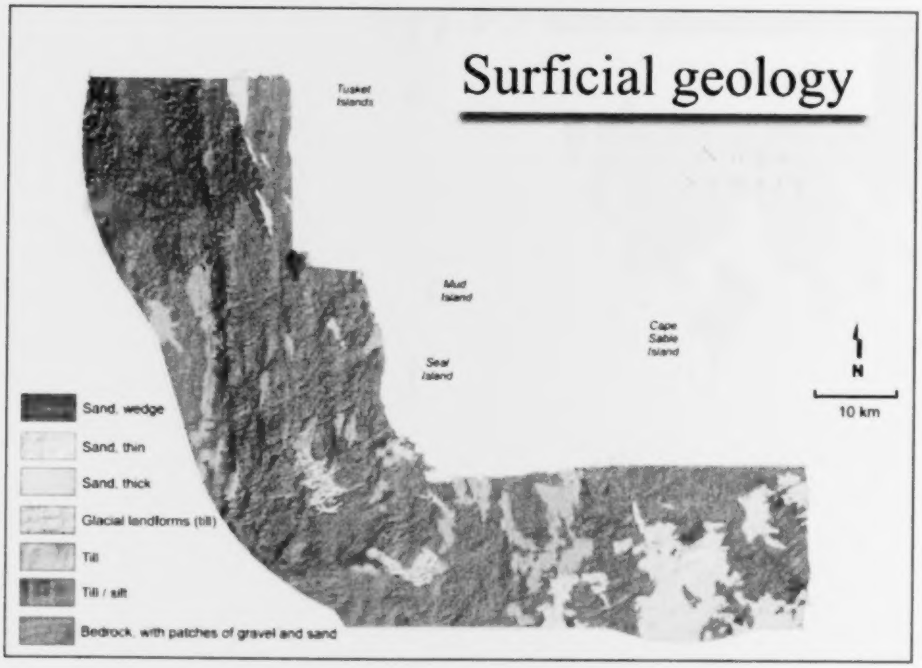

Figure 5. Surficial geology of Scallop Fishing Area 29.

Biological Data

Stephen J. Smith and Mark Lundy

Population Ecology Division
Department of Fisheries and Oceans
Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia, B2Y 4A2, Canada

There are three major sources of biological data from the scallop fishery in Scallop Fishing Area 29. The first is the scallop meat weight data collected by the dockside monitoring companies from a subsample of catches of the Full Bay Scallop fleet and the East of Baccaro Fleet licensed to fish in this area. For each catch sampled two 500 g samples of meats are taken and all scallop meats are weighed individually. While this information is used to compare landings against the regulated maximum of 33 meats per 500 g, these data can be use to characterize the overall size composition of the landings with respect to time and area.

An annual research survey has been conducted in this area since 2001. All of the surveys have been conducted on industry vessels with at least one DFO researcher on board when a vessel from the Full Bay Scallop Fleet was used. From 2001 to 2004, only vessels from the Full Bay Scallop Fleet were used but in 2005 a vessel from the East of Baccaro Fleet was used for the survey as well. Sampling on the East of Baccaro vessel was done by a fisheries observer. Comparative tows have been conducted between the Full Bay Scallop Fleet and East of Baccaro Fleet vessels used for the survey in 2005 and more comparative tows are planned for the 2006 survey.

A standard tow of 800 m was conducted at each of the random survey stations using commercial drags. Drag number 1 was lined with 38 mm polypropylene mesh to retain the smaller scallops. The catch in the two end drags (numbers 1 and 9) were sampled on each tow. The total number of tows has varied from 125 to 169 but not all tows are used for estimating abundance (Table 1). A number of tows were either exploratory in nature or used to collect ancillary information on bottom type. Meat weight and shell height data were collected to estimate yield and size composition of the population. Shells were retained for age determination. Lobsters caught in the survey are counted, measured for carapace length and condition. There are plans to count and measure all of the bycatch species in the 2006 survey.

A random survey design was used in 2001. From 2002 to 2004, a stratified random design was used with areas A to E as the strata (Fig. 1). In 2005, the strata were defined by bottom type (see Rowe et al. 2007).

Fisheries observers were used to monitor bycatch on the commercial vessels with a target of one observed trip for each vessel. The number and condition of lobsters in the catch are reported as soon as possible to DFO Fisheries and Aquaculture Management so that areas can be closed off if the bycatch is too high (Table 2). Numbers and weights of the other fish and invertebrate species in the catch are recorded as well.

References

Rowe, S., Smith, S.J. and Lundy, M.J. 2007. Benthic mapping in SFA 29: implications for scallop survey design. This volume.

Table 1. Total number of survey tows and index tows (tows actually used to estimate abundance) from the annual research surveys in Scallop Fishing Area 29. Details on biological data obtained from scallop catch are also given.

Year	Total Tows	Index Tows	Weight, shell height, Age samples
2001	125	120	838
2002	162	125	1311
2003	146	93	1279
2004	150	110	1034
2005	169	125	573

Table 2. Details on lobster condition obtained from the observer program from the 2004 fishery for both fleets in Scallop Fishing Area 29.

Area	No Injury	Injured	Dead	N/A	Total
A	10	3			13
B	415	61	15	9	500
C	41	5	1		47
D	2		1		3
E	16	4			20
Total	484	73	17	9	583

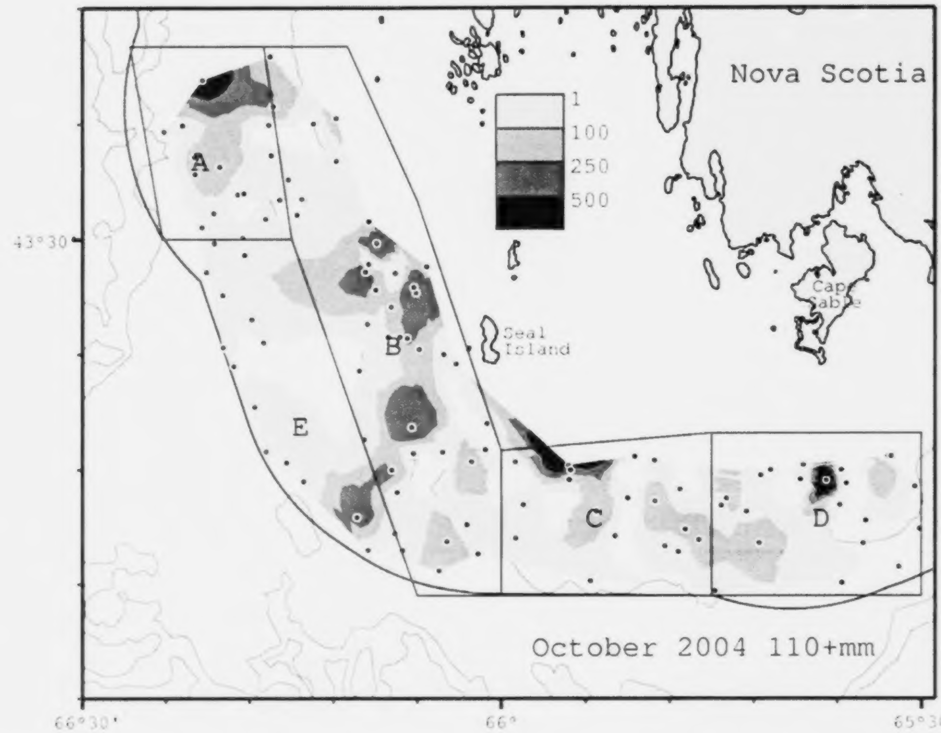

Figure 1. Spatial distribution of scallops for shell heights 110 mm and larger (corresponding to approximately age 7+) caught during the 2004 research survey in Scallop Fishing Area 29. Darkening shades of grey within isopleths refer to increasing numbers of scallops per standard tow. Dots depict tow locations.

Fisheries Management Data

M. Butler[1] and M. Hartley[2]

[1]Fisheries and Aquaculture Management
[2]Conservation & Protection
Department of Fisheries and Oceans
Marine House
PO Box 1035
176 Portland St
Dartmouth, NS. B2Y 1J3

Fisheries and Aquaculture Management is comprised of several groups including Resource Management, Conservation and Protection, Regulation, Licensing, Aboriginal Fishers and Aquaculture. Resource Management provides the liaison between the DFO branches and industry participants for the development of and for the duration of the joint project agreements (JPA). We conduct the consultations between DFO, industry stakeholders and first nations in the development of fishing plans outlining management strategies.

Management strategies for the SFA 29 Scallop fishery include 100% hail in and hail out along with catch weight verification and log data entry with quota monitoring. Compliance with area and season regulations are monitored using the hail out and the VMS monitoring. Meat count/shell height is monitored by Conservation and Protection. At-sea observer coverage is used to monitor lobster by-catch which is an important component of this fishery.

We are moving from objective-based management to ecosystem-based approaches to management. This means managing human activity (in this case fishing) in a way that controls how the activity will impact the ecosystem while at the same time recognizing how the ecosystem influences the way we should regulate this activity.

As we have seen today we have spatial tools available that could result in managing at a smaller scale than is presently being done. Some of these tools have already been used to assist in managing certain aspects of the fishery.

Summary of Resources Used

Stephen J. Smith

Population Ecology Division
Department of Fisheries and Oceans
Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia, B2Y 4A2, Canada

The amount of $385,000 from the fishing industry was a substantial contribution to the overall costs of the SFA 29 bottom mapping and fishery monitoring project (Table 1). It is unlikely that the bottom mapping component could have gone ahead without this money. The government contributions reflect both the investment of operating funds as well as salaries for NRCan and DFO staff for their time on this project. The largest portion of the funds was used by the Canadian Hydrographic Service in support of contracts for data management (Table 2).

Table 1. Breakdown of contributions from fishing industry and government partners in the Scallop Fishing Area 29 JPA (2002–2005). All amounts are in thousands of dollars. The allocation of industry amounts to government partners reflects how the money was used. The funds in 2005/2006 represent a carry-over to finish off the project.

	2002/2003		2003/2004		2004/2005		2005/2006		Grand Total	
	Ind.	Govt.	Ind.	Govt	Ind.	Govt	Ind.	Govt	Ind.	Govt.
DFO/SCI	7.90	50	6.43	50	7.88	60			22.22	160
DFO/FAM	27.68	30	8.92	20	11.96	20	0.59		49.14	70
DFO/CHS		210	124.17	653	84.28	41	25.00		233.46	904
NRCAN		100	80.00	300		100			80.00	500
Total	35.58	390	219.52	1023	104.13	221	25.59		384.82	1634

Table 2. Breakdown of project expenses charged against the fishing industry contribution of $385,000. All amounts are given in thousands of dollars.

	NRCAN	DFO/CHS	DFO/SCI	DFO/FAM
VMS				48.55
Contracts	25.00	180.98		
Materials	29.00		3.59	
Travel	6.00	4.58	4.98	0.59
O/T	25.00	13.22		
Products	20.00	22.90	0.43	
Total	80.00	233.46	22.22	49.14

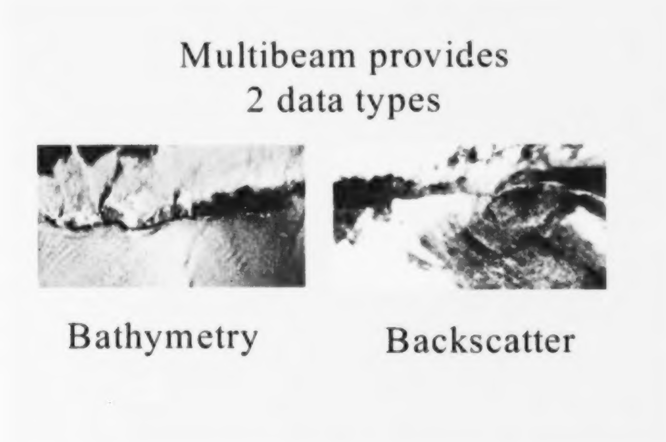

Figure 3. Multibeam data types.

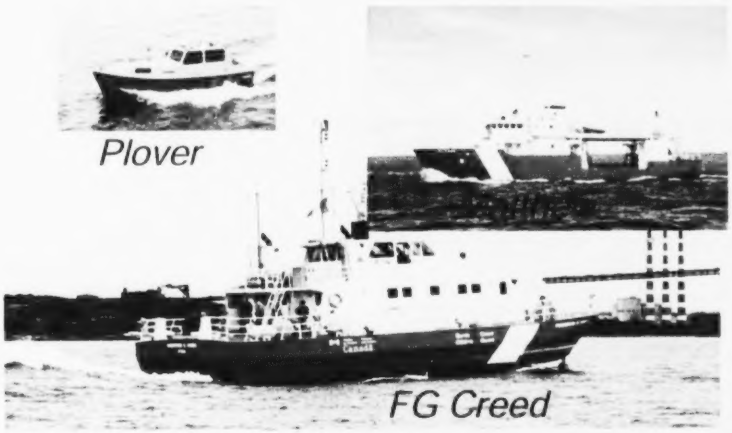

Figure 4. DFO ships with Multibeam sounders installations.

III. DATA ANALYSIS AND APPLICATIONS

Observations on Distribution of Benthic Fauna and Habitats of German Bank (Nova Scotia, Canada)

V.E. Kostylev and B. J. Todd

Geological Survey of Canada (Atlantic),
Natural Resources Canada,
Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia, B2Y 4A2, Canada

Introduction

German Bank habitat studies are closely linked with fishery issues, such as scallop dragging, lobster and crab fisheries. Early research led by Natural Resources Canada (NRCan) on the Southern Banks in the Gulf of Maine (Todd et al., 1999; Manson and Todd, 2000; Kostylev et al., 2001; Kostylev et al., 2003) targeted an applied problem — how geological and geophysical information can be used for improving catches of scallops. Multibeam bathymetric mapping has proven to be of a great help for understanding seabed structure, texture and processes. For example, on Browns Bank the acoustic backscatter alone was shown to be correlated to expected scallop catch (Kostylev et al., 2003). With a more conscientious approach to fisheries a new set of problems came to the forefront of seabed research. Namely, how can geological information be used to facilitate the management of the fishery, preserve seabed habitat and benthic communities, and minimize bycatch? In order to address these questions, NRCAN in cooperation with the Department of Fisheries and Oceans (DFO) has analyzed an interdisciplinary set of data, which includes oceanographic, geological and biological information.

The purpose of this report is to describe preliminary results of seabed observations on German Bank on the basis of photographic, video and fishery observer data. Seabed imagery provides valuable information on the current state of seabed habitats, while observer data provided details on the success of the commercial fishery and the amount of bycatch. Abundance of bycatch is interpreted as an indication of the damage incurred by seabed habitats as a result of fishing activity.

Methods

Seabed bathymetry, acoustic backscatter and geological patterns were mapped using multibeam sonar, grab samples, and video observations. Details of field sampling and geological mapping are provided by Todd (2007). Relationships between benthic fauna with sediment types (fishery observer data) were established by calculating average weight per tow in each sediment type.

Results

Our photo and video observations revealed that the German Bank seabed is very diverse and heterogeneous. Geological complexity of the seabed is the result of interaction of glacial and modern processes, and structurally habitats vary from exposed bedrock to sand wave fields and from silt to bouldery glacial retreat moraines (Todd et al., in press). Benthic fauna of these habitats are naturally dependent on the types of substrate they can attach to or burrow into.

In the deeper parts of the bank (100–140 m water depth), muddy sand with patches of amphipod or polychaete tubes dominates flat, somewhat hummocky seabed (Fig 1A). Sediment varies from gravely sand to mud. Poorly developed current ripples are commonly observed on the surface of muddy sand. Benthic megafauna includes the dominant burrowing anemone *Cerianthus borealis* and shrimps *Pandalus* sp., with less common Jonah crabs (*Cancer* sp.) and hermit crabs (*Pagurus* sp.). Some hakes (*Urophycis* sp.), monkfish (*Lophius Americanus*) and several species of flatfish are found near the seabed. Benthic epifauna in this part of the bank are generally scarce.

In 50–100 m water depth, highly complex and heterogeneous seabed varies from exposed bedrock through cobbles and boulders to sandy gravel and shell hash beds. Fauna on hard substrates (exposed bedrock and topographically complex mixed sediments, Fig 1B) included a variety of encrusting and erect sponges, sea stars (*Asterias* sp., *Crossaster papposus*, *Solaster endeca*, *Hippasteria phrygiana*), tunicates (*Boltenia ovifera*), brachiopods (*Terebratulina* sp.) and soft corals (*Gersemia* sp.). Fish are commonly observed in the complex rocky habitat. Calcareous polychaete tubes, likely of *Filograna implexa,* and sponges are generally characteristic for poorly sorted sediments. *Asterias* sp., *Crossaster* sp. and *Hippasteria* sp. are also common on sandy gravel and gravely sand, as well as on shell beds containing populations of horse mussels *Modiolus modiolus* (Fig 1C). Hard substrates are commonly overgrown with dense mats of hydrozoa and bryozoa, but patches of sand and sandy mud occurring among till and bedrock outcrops have scarce fauna (Fig 1D), with *Hyas aranaeus*, *Strongylocentrotus* sp. and infrequent occurrence of flatfish.

Within a similar water depth range in the northwest part of the bank, dominated by drumlins, seabed texture varies from gravelly mud to complex cobble and boulder bottom. Abundant epifauna with low diversity is commonly observed on hard substrates. Groundfish, Jonah crab (*Cancer* sp.) and sea scallops (*Placopecten magellanicus*) are common on gravely sand in troughs between drumlins. Anemones and *Asterias* sp. as well as abundant erect and encrusting (*Halichondria panicea*) sponges are common in the complex habitat on drumlins.

On sand deposits in the southeast of the bank (Fig 1E) brittlestars (*Ophiura sarsi*) are abundant in deeper waters (70 m), along with less frequent *Strongylocentrotus* sp., *Hippasteria phrygiana*, *Pagurus* sp., *Colus* sp., *Buccinum* sp., *Neptunea* sp. hydrozoa, bryozoa and anemones, both burrowing and non-burrowing. Shallower sands (30–40 m) usually contain abundant shell fragments and mussel shells (Fig. 1F). These habitats have scarce fauna, which includes *Placopecten magellanicus*, and *Modiolus modiolus* with anemones and sponges (*Polymastia sp.)* occurring where patches of hard substrate are available.

In near shore shallow waters (2–40 m) the seabed is dominated by bedrock and boulders with a few patches of sand. Boulders are covered with *Lithothamnium* sp. and densely colonized by fauna typical for southern Nova Scotia near shore environments (Fig 1G). The frilled anemone *Metridium senile* is very abundant along with the stalked tunicate *Boltenia ovifera*. Prolific fauna includes *Modiolus modiolus*, as well as encrusting, erect (*Haliclona oculata*) and mound-shaped sponges, and echinoderms (*Asterias* sp., *Henricia* sp., *Strongylocentrotus* sp.).

Because of the general homogeneity of oceanographic processes on the bank, no strong broad-scale gradients in benthic fauna composition were noticed in the analysis of the observer data. Some exceptions are the boreal species such as sea cucumber (*Cucumaria frondosa*) and basket stars (*Gorgonocephalus arcticus*) which were more abundant in the

relatively colder south-eastern part of the bank; lobsters (*Hommarus americanus*) and Jonah crab (*Cancer* sp.) were more abundant in the western part of the bank, possibly because of the temperature preference of these species. The majority of the species, however, were more dependent on the local habitat structure. Analysis of the distribution of benthic assemblages (as defined by cluster analysis of observer data) showed that they are scattered in a mosaic fashion, often associated with topographic or geological features. For example, an assemblage characterized by high abundance of crabs, skates and lobsters was commonly found in muddy, flat valleys between the sets of moraine ridges. Based on these preliminary observations it is concluded that most of the variability in distribution of commercial species and bycatch is explained by the geological patterns.

Conclusions

Sea scallops (*Placopecten magellanicus*), while being generally abundant through the study area, are more commonly observed on flat gravel lag (Fig. 1H) or stable sands. They are the least common in complex and biologically diverse habitats, such as moraines and bedrock outcrops. This observation enables prediction of the success of the scallop fishery in different parts of the study area. Dragging for scallops on the flat gravel lag or in sand will improve catches, minimize gear losses and greatly reduce bycatch and damage to epibenthic communities, which are the most abundant on bedrock outcrops and till.

References

Kostylev, V.E., R.C. Courtney, G. Robert, and B.J. Todd. 2003. Stock evaluation of giant scallop (*Placopecten magellanicus*) using high-resolution acoustics for seabed mapping. Fisheries Research 60: 479–492

Kostylev, V.E., B.J. Todd, G.B.J. Fader, R.C. Courtney, G.D.M. Cameron, and R.A. Pickrill. 2001. Benthic habitat mapping on the Scotian Shelf based on multibeam bathymetry, surficial geology and sea floor photographs. Marine Ecology Progress Series, 219: 121–137.

Manson, G., and B.J. Todd. 2000. Revolution in the Nova Scotia scallop fishery: seabed maps turn hunting into harvesting. Fishing News International 39(2):20–22

Todd, B.J. 2007. Surficial geology of Scallop Fishing Area 29, southwest Nova Scotia. This volume.

Todd, B.J., G.B.J. Fader, R.C. Courtney, and R.A. Pickrill. 1999. Quaternary geology and surficial sediment processes, Browns Bank, Scotian Shelf, based on multibeam bathymetry. Marine Geology 162:165–214

Todd, B.J., P.C. Valentine, O. Longva, and J. Shaw. 2007. Glacial landforms on German Bank, Scotian Shelf: evidence for late Wisconsinan ice sheet dynamics. Boreas. 36: in press.

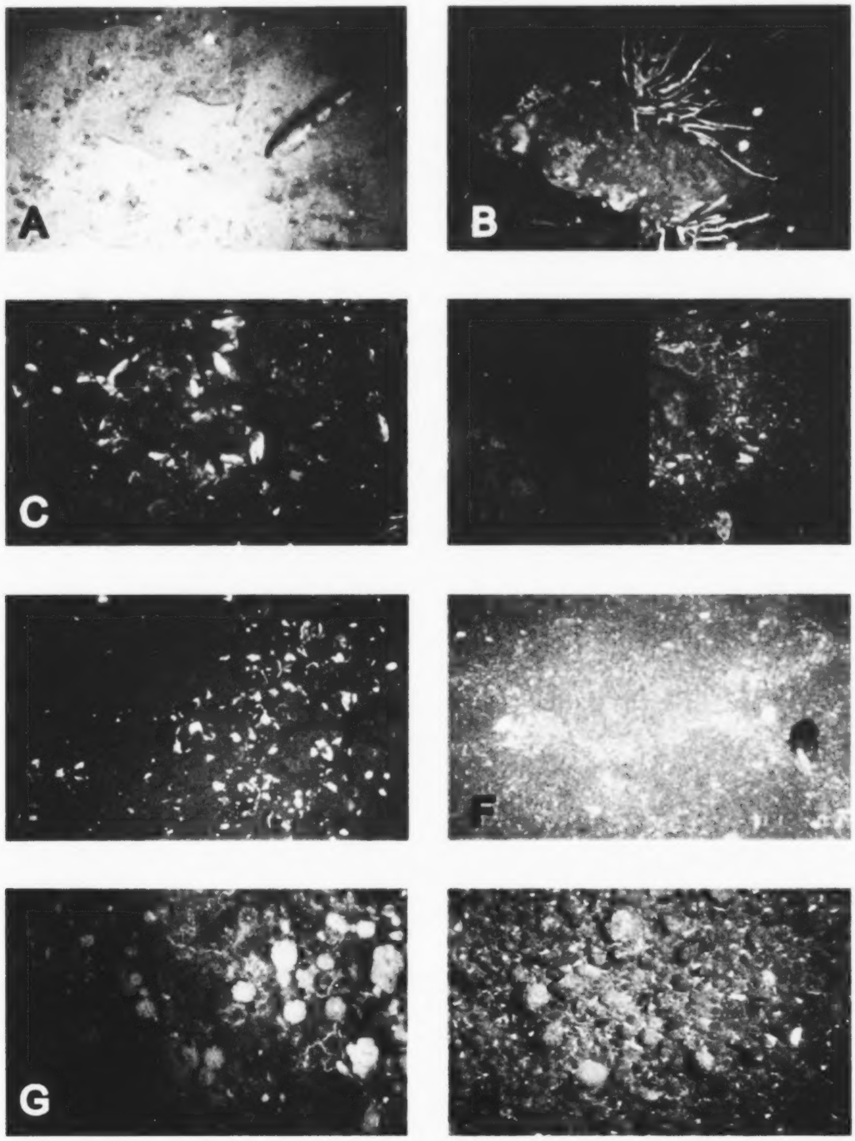

Figure 1. A: Muddy sand with patches of amphipod or polychaete tubes dominating a flat, somewhat hummocky seabed in the deeper parts of the bank (100–140 m water depth). B: Highly complex and heterogeneous seabed at 50–100 m water depths. Fauna on exposed bedrock and topographically complex mixed sediments included a variety of encrusting and erect sponges. C: Horse mussel Modiolus modiolus bed on sandy gravel mixed with shell debris. D: Contrast between hard substrates commonly overgrown with dense mats of hydrozoa and bryozoa (left panel) and patches of sand and sandy mud occurring among till and bedrock outcrops. E: Brittlestars (Ophiura sarsi) are abundant in deeper waters (70 m) on fine sands. F: Shallow sands (30–40 m) contain abundant shell fragments and disarticulated mussel shells. G: Nearshore shallow waters (20–40 m) are dominated by bedrock and boulders covered with Lithothamnium sp. and densely colonized by typical for southern Nova Scotia near shore fauna (e.g. the frilled anemone Metridium senile). H: Sea scallops (Placopecten magellanicus) are more commonly observed on even seabed covered with gravel lag.

Benthic Mapping in SFA 29: Implications for Scallop Survey Design

S. Rowe, S.J. Smith, and M.J. Lundy

Population Ecology Division
Department of Fisheries and Oceans
Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia, B2Y 4A2, Canada

Fisheries-independent estimates of abundance are integral to the evaluation of stock status. The precision associated with these survey-based abundance estimates can, however, greatly affect the reliability of stock assessment results. In the present study, we evaluated a new stratified-random design, based on surficial geology, for estimating the abundance of sea scallops (*Placopecten magellanicus*) in the portion of Scallop Fishing Area (SFA) 29 west of longitude 65°30'W. The survey series for SFA 29 was initiated in September 2001. Very little was known about the local distribution of scallops at this time and, consequently, tows were randomly allocated over the entire survey area. Based on the results of the 2001 survey, SFA 29 was subdivided into five geographic 'zones' or strata named A, B, C, D, and E. During 2002–2004 surveys, tows were randomly assigned within each of the zones and allocated in proportion to stratum size. Unfortunately, Zone E has not been consistently covered in the survey due to time limitations; this area is considered to be marginal habitat for scallops and, as a result, has been less of a survey priority. In 2005, the survey was re-designed, such that stratification was based on the bottom type information obtained from multi-beam mapping and geological ground truth analyses recently conducted in SFA 29. Specifically, tows were randomly assigned within bottom types and allocated in proportion to the mean/variance of scallop abundance in each stratum observed during 2001-2004 and according to stratum size. The justification for changing the stratification scheme was that the new stratum boundaries might be more closely related to the spatial distribution of scallops which, in turn, would reduce the variance and improve the precision of the survey abundance estimates. For the purpose of comparing survey designs, we restricted our analyses to those portions of Zones A, B, C, and D that have been covered by multi-beam mapping and that represented one of the four most prominent bottom types found in SFA 29 (bedrock, glacial till, thin sand, and till/silt).

The change in stratification in 2005 does not appear to have changed the overall trend in scallop abundance (Fig. 1). While estimates from both stratification schemes indicate a dramatic increase in 2005, this increase is mainly due to the large increases in Zones B and D. Increases in 2005 occurred mainly on thin sand and bedrock, bottom types typical of Zones B and D. In order to assess the efficiency of each stratified-random design, we calculated the relative efficiency (Smith and Gavaris 1993) which is a function of the variance from stratified-random sampling relative to the variance from simple random sampling. Within this context, gains in relative efficiency may result from the allocation scheme (number of tows conducted in each stratum) or the stratification scheme (definition of stratum boundaries). Allocation gains may be negative, zero, or positive depending on whether allocation of tows to strata is arbitrary, proportional to stratum size, or optimal (i.e., proportional to the combination of stratum size and variance). Stratification gains may be greater than or equal to zero depending on whether stratification was successful in increasing the variance between strata relative to the variance within strata. We found that there was a net gain in relative efficiency in association with the new stratified-random design based on surficial geology in 2005 (Table 1). This net gain in relative efficiency was attributable to increases in both allocation and stratification components. In conclusion,

stratification of the SFA 29 scallop survey on the basis of surficial geology appears to have improved the precision of abundance estimates. Further gains may be achieved through improved allocation of tows to strata and refinement of strata boundaries.

References

Smith, S.J., and S. Gavaris. 1993. Improving the precision of abundance estimates of Eastern Scotian Shelf Atlantic cod from bottom trawl surveys. North American Journal of Fisheries Management 13: 35–47.

Table 1. Relative efficiency of abundance estimates obtained for scallops (≥80 mm shell height) from the 2001–2005 surveys of Scallop Fishing Area (SFA) 29 west of longitude 65°30'W.

				Relative efficiency (%)		
Year	Stratification scheme	Stratified mean	Stratified SE	Allocation	Stratum	Total
2001	Zone	239.58	58.00	1.49	4.96	6.45
2002	Zone	289.27	36.91	1.68	7.53	9.21
2003	Zone	363.42	45.01	6.65	1.57	8.22
2004	Zone	189.29	31.59	-4.84	1.33	-3.51
2005	Bottom type	253.97	34.02	7.74	9.06	16.81

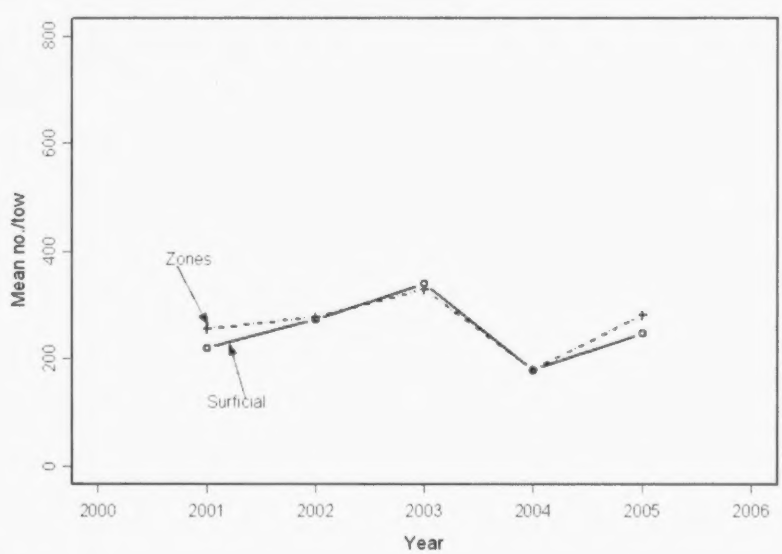

Figure 1. Mean number per tow for commercial size scallops (shell height 80 mm and greater). Annual research surveys in Scallop Fishing Area 29.

APPENDIX 2: Agenda

Presentation and review of Southwest Nova Scotia benthic mapping project:

February 16, 2006

I. Introduction:

9:00 Opening comments: R.A. Pickrill (NRCan/GSC)
9:05 Brief history of project: S.J. Smith (DFO/Science)

II. Data collected:

9:20 Multibeam Bathymetry and backscatter data: G. Costello (DFO/CHS)
9:40 Geoscience and groundtruth data: B. Todd and V. Kostylev (NRCan/GSC)
10:10 Health break
10:40 Biological data (scallop survey): S.J. Smith and M. Lundy (DFO/Science)
11:00 Fisheries data (VMS, observer): M. Butler et al. (DFO/FAM)
11:20 Summary of resources used for this project: S.J. Smith (DFO/Science)

12:00 Lunch

III. Data Analysis and applications:

13:00 Habitat classification: V. Kostylev and B. Todd (NRCan/GSC)
13:30 Commercial fishing: M. Lundy (DFO/Science), K. Ross (Full Bay Scallop Fleet)
14:00 Survey design: S. Rowe, S.J. Smith and M. Lundy (DFO/Science)
14:30 Commercial Catch rates: J. Black and S.J. Smith (DFO/Science)
15:00 Health break.
15:30 Fisheries Management (Fishing areas, bycatch management): M. Butler et al. (DFO/FAM)
16:00 Summary and follow-up:

IV. Next steps:

16:30 NRCAN's plans 2006–2009: R. Pickrill (NRCan/GSC)
16:45 DFO's plans 2006+: S.J. Smith (DFO/Science)

Realities of SFA 29 Scallops and Seabed Mapping

M.J. Lundy[1] and Captain K. Ross[2]

[1]Population Ecology Division
Department of Fisheries and Oceans
Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia, B2Y 4A2, Canada

[2]Digby, NS (deceased)

The whole area inside the twelve mile territorial sea below latitude 43°40'N and west of longitude 65°30'W had not been legally fished prior to 2001 although there were limited defined fishing areas in the western portion of the area in the mid 1990's. The central and near shore area was named "no man's land" as there had been no legal fishing there. Extra ship time (DFO research vessel CCGC J.L. Hart) during the August 2000 scallop production area 3 survey enabled exploratory sampling below latitude 43°40' N. As the bottom was observed to be very rough tows were made against the tide to limit gear damage. Overall catch rates were very high (75–115 kg/h). These exploratory tow results were presented to the Inshore Scallop Advisory Committee in the spring of 2001. Consultations with lobster industry resulted in an agreement of a 400 mt fishery for the summer of 2001. Industry targeted high catch rates observed in 2000 DFO exploratory sampling resulting in an average commercial catch rate of 110 kg/h. Due to the rough bottom, fishing in this area came with a cost as many vessels lost gear and/or damaged vessels.

An industry funded post-season survey was conducted on the F/V Julie Ann Joan in 2001 with tow locations being randomly selected over the whole area. Many of the tows occurred on very rough/hard bottom and the scallop gear was constantly being repaired. Many of the tows would have been questionable if a wooden hulled vessel had been involved.

Based on the 2001 survey results, the large area was subdivided into 5 subareas A–E with corresponding quotas for the 2002 fishery. A multibeam survey of area C was initiated in 2002. The resultant maps showing bottom features (bathymetry and backscatter) were available for the 2002 fall survey. Survey tow locations and tow direction were aligned with bathymetry in the bottom mapped area (area C).

The fishery has continued to present day with the completion of bathymetric maps in 2003 and the surficial geology map in 2005. Through the use of these seabed maps the skipper can make better decisions on where and how to tow the scallop gear. The decreasing percentage of gear hook-ups on the survey as bottom mapping information became available demonstrates the benefits of having these maps (Table 1). Figure 1 illustrates a tow completed prior to access to seabed mapping where a hook-up occurred. Had the mapping been available the tow direction would have been changed away from the rough bottom ridges.

With the familiarization of the seabed maps some fishermen are now using bathymetry and backscatter maps to determine where they can tow the scallop gear with minimal damage and more efficient fishing. This eliminates the need to "feel" the bottom by doing many tows in different patterns and also lessens the impact of the gear on the substrate.

In summary seabed mapping is an extremely powerful tool for the scallop fishery.

It has proven to decrease damage to gear and/or reduce gear impact while increasing DFO science's ability to assess and provide advice towards a sustainable fishery (See Rowe et al. 2007, Black and Smith 2007).

References

Black, J., and S.J. Smith. 2007. Scallop commercial catch rates in Scallop Fishing Area 29. This volume.

Rowe, S., S.J. Smith, and M.J. Lundy. 2007. Benthic mapping in SFA 29: implications for scallop survey design. This volume.

Table 1. Percentage of survey tows where the gear hooked up due to rough bottom.

Year	Hook-ups	Map availability
2000	10%	
2001	14%	
2002	14%	Area C Map
2003	3%	All areas mapped
2004	6%	All areas mapped
2005	2%	Surficial geology map

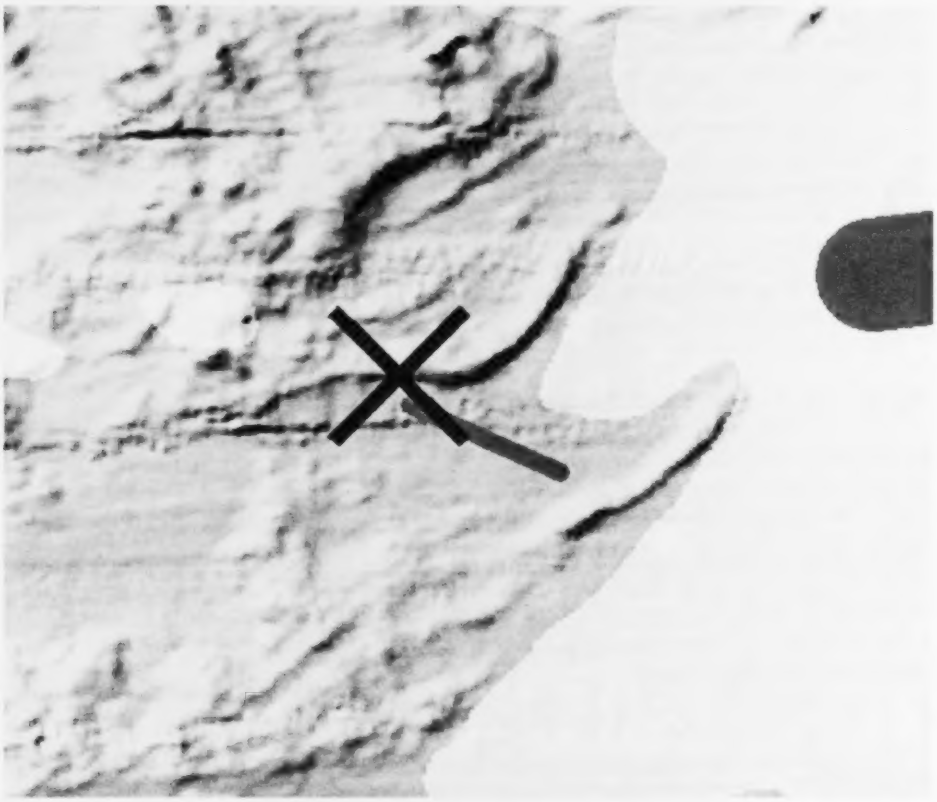

Figure 1. Tow track of a survey tow made before multibeam bathymetry was available. X marks the beginning of the tow. This tow hooked up on the ridge at the end of the tow.

Scallop Commercial Catch Rates in Scallop Fishing Area 29

J. Black and S.J. Smith

Population Ecology Division
Department of Fisheries and Oceans
Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia, B2Y 4A2, Canada

The availability of Vessel Monitoring System (VMS) positional information and bottom type derived from the Scallop fishing area 29 multibeam survey permitted the comparison of commercial catch rates from a new perspective. Commercial catch rate data are often used to monitor changes in abundance, with the assumption that changes in catch rate are proportional to the population abundance. While there are many factors that may mask the efficacy of catch rate as an indicator, the general presumptions are that no change in observed catch rate is indicative of a sustainable fishery, while an increase/decrease in catch rate may indicate that removals are less than/greater than production from growth and recruitment (Figs. 1 and 2).

A significant complication in using catch rates for scallop fisheries is the ability of the fleet to maintain catch rates by targeting new fishing grounds. To detect evidence of changes in the spatial distribution of fleet activity, the fishing log book data and VMS positional information were compared.

The VMS data provide hourly positional information for each vessel without an indication of vessel activity (Fig. 3). The vessel speed is available from some vessel instrumentation, or sometimes may be inferred with additional error from successive observations. Low speed observations (less than 4 knots) were used as indicators of where fishing activity may have occurred. The distribution of VMS positions and log book data were compared using the bottom type classification to partition the data.

The VMS and log book data both indicated significant fishing activity in the be Bedrock granitic, Glacial till and Thin sand bottom types, and preferential fishing activity occurred in the Glacial till and Thin Sand bottom types, exceeding that expected by the available area (Figs. 4 and 5, Table 1).

Comparison of log book catch rate and VMS positional data for 2003–2005 indicated that in some areas, area fished changed on a yearly basis (ignoring areas where management restrictions affected fishing distribution) (Figs. 6 and 7). As a result, catch rates should be used with caution when used as an abundance index.

Table 1. Satellite vessel monitoring system (VMS) data categorized by bottom type. Speeds less than 4 kt assumed to indicate vessel was fishing. Percentage of logbook positions by bottom type. All fisheries data from 2003 to 2005.

	Bedrock granitic	Glacial landforms till	Glacial till	Thick sand	Thin sand	Sand wedge	Till silt
No. VMS records<4 kt	5281	43	2604	25	1836	8	225
Percentage VMS <4 kt	52.7	0.4	26.0	0.3	18.3	0.1	2.2
Percentage logbooks	59.1	0.4	18.9	2.9	16.2	0.0	2.4
Percentage area by bottom type	66.7	0.7	7.1	0.6	10.4	0.2	14.3

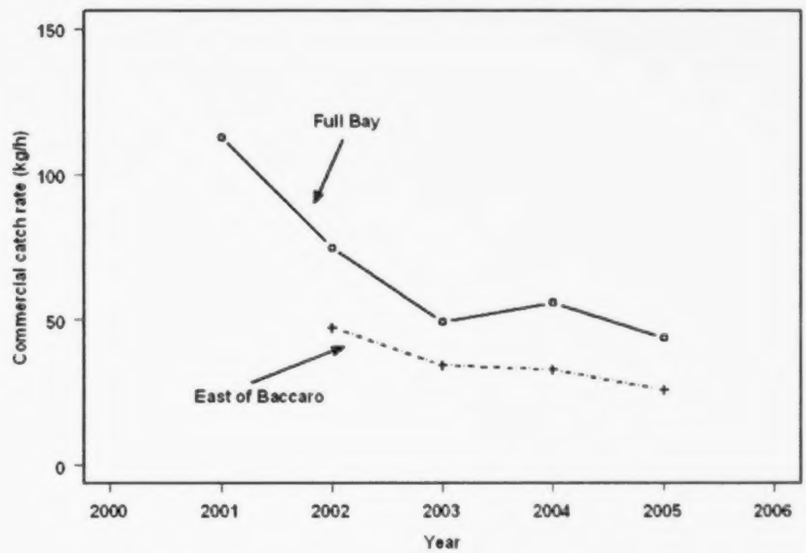

Figure 1. Catch rates by fleet in Scallop Fishing Area 29.

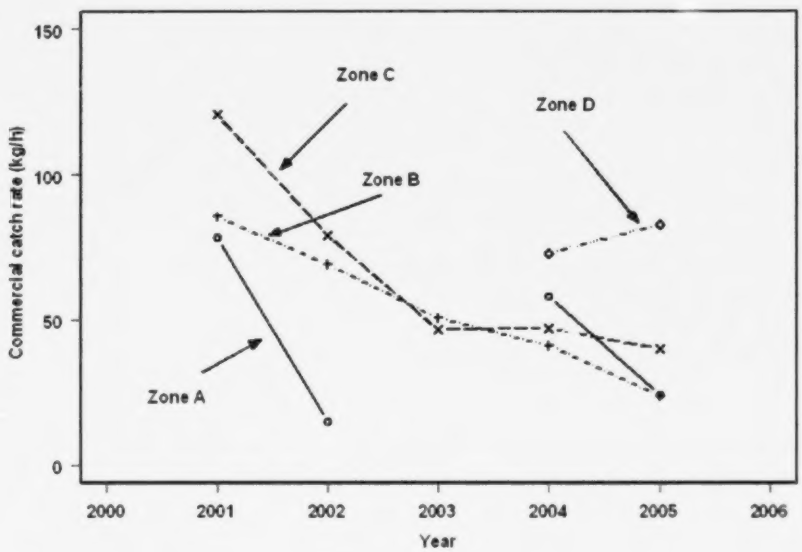

Figure 2. Full Bay Fleet catch rate by zones in Scallop Fishing Area 29.

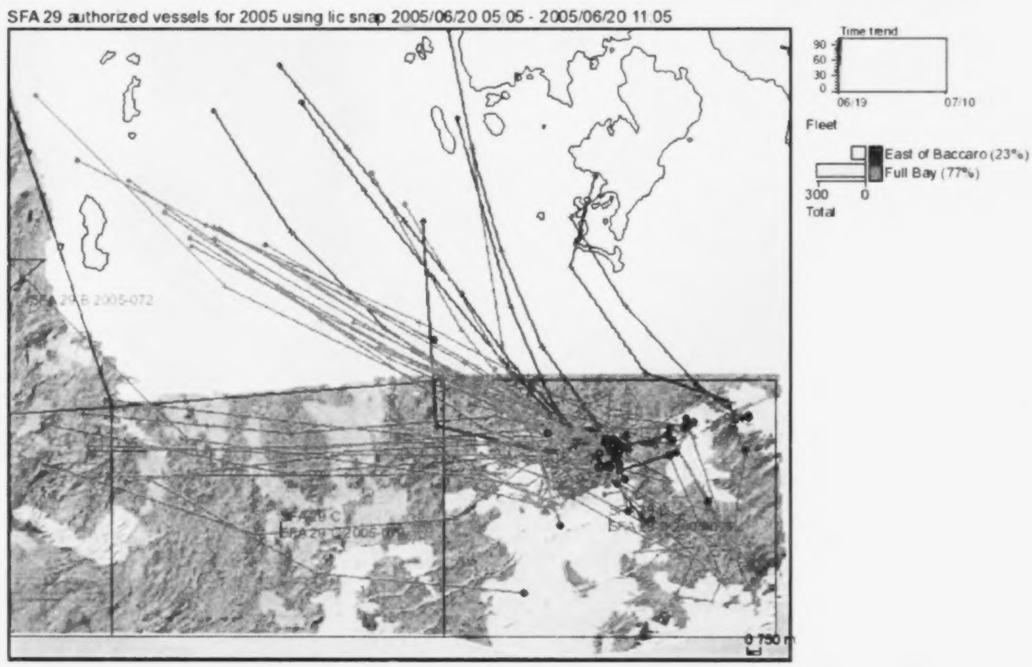

Figure 3. Fleet activity for a 6 hour time period from VMS positional information. Scallop Fishing Area 29.

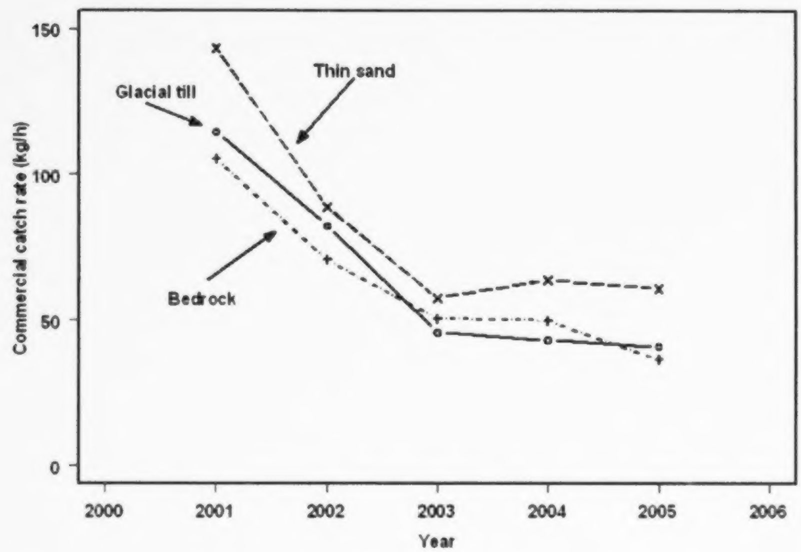

Figure 4. SFA 29 Full Bay Fleet catch rate (2001–2005) by bottom type in Scallop Fishing Area 29.

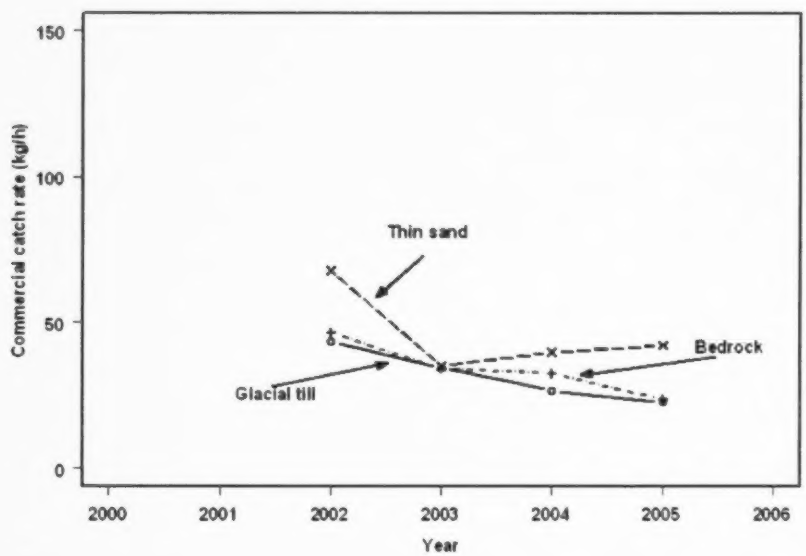

Figure 5. SFA 29 East of Bacarro fleet catch rate (2001–2005) by bottom type in Scallop Fishing Area 29.

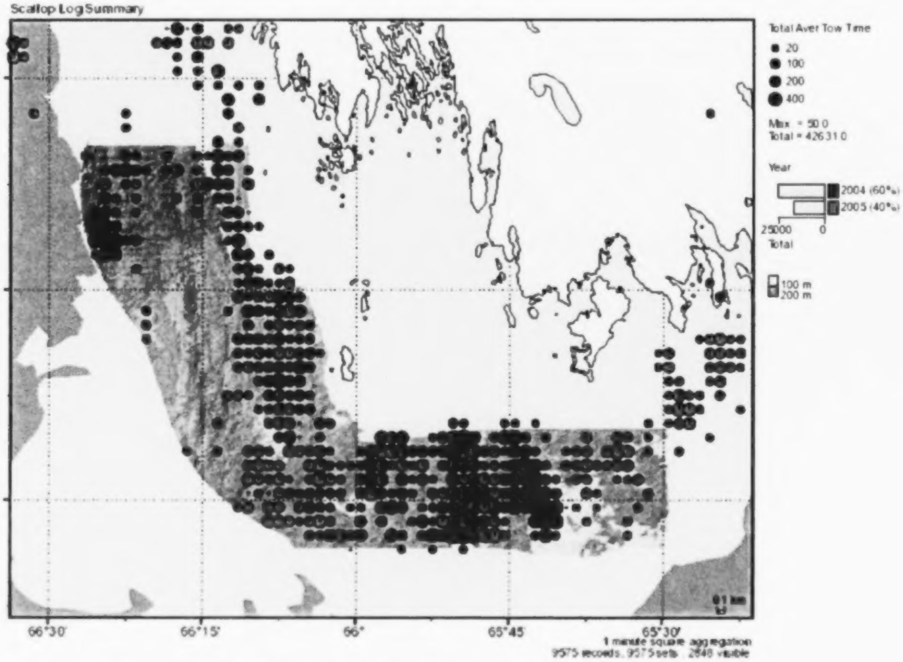

Figure 6. Log book summary for 2004-2005 for Scallop Fishing Area 29.

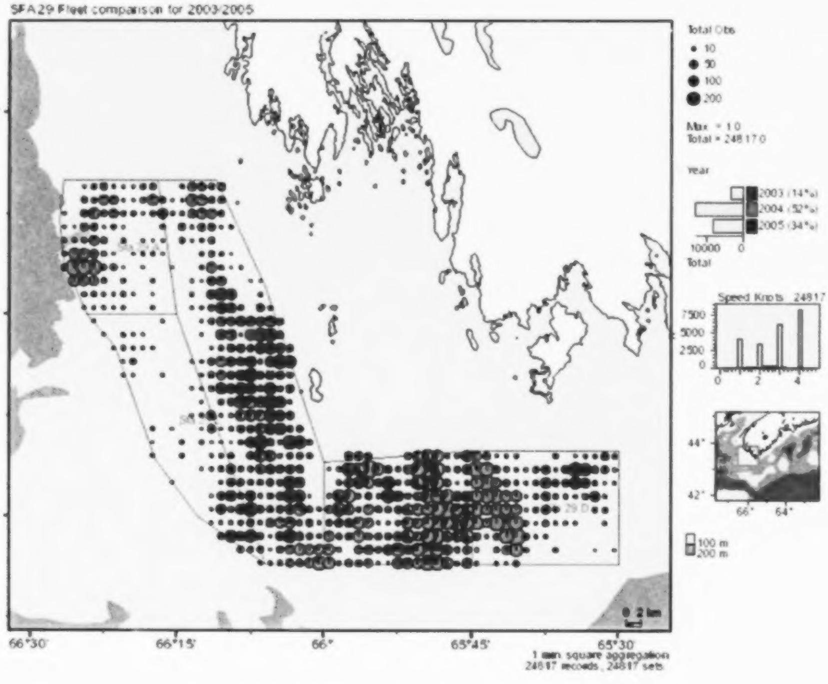

Figure7. VMS summary for 2004–2005 for Scallop Fishing Area 29. Within each pie-chart, the different colours represent the number of observations by years in the same one minute square.

Fisheries Management (Fishing Areas, Bycatch Management)

Jack Lowe

Conservation & Protection
Department of Fisheries and Oceans
215 Main Street
Yarmouth, Nova Scotia B5A 1C6

The year 2005 was the fourth consecutive year that Southwest Nova Scotia scallop vessels were monitored using an electronic *Vessel Monitoring System* (VMS) while fishing in Scallop Fishing Area 29 (SFA 29). The program has been developing and evolving each year as the uses of the system and its potential as an enforcement mechanism for DFO C&P personnel become clearer and further exploited. It is now possible for staff to track vessels and check the areas they are licensed to fish and compare hail information from vessels that are fishing. A summary of enforcement activities to date are given in Table 1. The investigations that were conducted consisted of checking for vessels being in the wrong area, improper hails and for vessels in closed areas. Enforcement efforts to monitor the fishery averaged about 1500 man hours per year.

Three main tools were used to monitor the Scallop Fleet in Southwest Nova Scotia. These were hails, licensing information and VMS. Hail-outs and hail-ins by scallop vessels were primarily accessed through the DFO MARFIS statistical data system. The virtual data centre (VDC) was used to display and query the VMS information.

Time did not always allow for random audits, so if a vessel or group of vessels were suspected of irregular activity, they would be queried and selectively audited. A wide array of problems arose while auditing vessels and each case was dealt with on an individual basis. The three biggest problems most frequently detected upon performing audits were no signals from a vessel, periods of signal loss from a vessel and signals from outside of a vessel's licensed area. Audits were also very useful in estimating vessel departure and arrival times when no hail-outs or hail-ins were made, or the vessel did not depart or land near the time specified on the hail.

The VMS operator kept track of vessels that carried at-sea Fisheries Observers. This was a relatively easy task to complete and it strengthened VMS data in the event of incidents. VMS data coupled with that of an observer helps form a more solid foundation of evidence for DFO than either source of information alone. Tracking of observed trips was accomplished through direct communication with Javitech Limited, the observer provider in Scotia Fundy Region. Personnel from Javitech provided daily faxes indicating which scallop vessels had observers deployed to them. Javitech personnel also provided a copy of a database containing information regarding observed vessel trips and dates mid-way through the season and nearing completion of the fishery.

The SWNS Area Office received on a routine basis at-sea observer reports from Javitech. Based on an assessment of larger than average lobster by-catch data from more than one scallop vessel fishing in the same area, the SWNS Area Office contacted the respective scallop fleet representatives and recommended closure. There were closures recommended each year of the fishery and all recommended closures were accepted by the fleets. Many of the same areas were closed each year possibly indicating a migration of lobsters into the

same areas at the same time each year. The area 29B was the most problematic with respect to lobster by-catch.

Using VMS, fishery officers can better plan their patrol efforts and activities. Patrols can be directed towards identified problems and areas of concern. In addition, fishing patterns can be identified.

Table 1. Enforcement activities for the Scallop Fishing Area 29 fishery.

Year	No. of Vessels	No. of Trips	No. of Audits
2002	76	833	167
2003	76	271	28
2004	79	652	39
2005	79	347	24

Summary and Questionnaire

Discussion after the presentations focussed on everything from availability of the data to using these kinds of data to manage fisheries. Overall, the fishing industry representatives were positive about the results but would have preferred to have more control over their participation. Access to fishing in this area was conditional on their contributing to funding the project.

Recall that the participants at the meeting were asked to provide answers for the following four questions. There was a short period of time at the end of the meeting to discuss these questions but it had been a long day and participants wanted time to think about what had been presented. Unfortunately, few responses were received after the meeting and these are summarized below.

1. How can this kind of information be used to manage fisheries and other activities?

It is too soon to identify all of the potential applications of bottom map data to the management of fisheries and other ocean activities. The critical next step is defining the linkages between seabed habitat and the occurrence of different benthic organisms. Once this has been done, it is likely that this information could be used to delineate more specific areas for fishing, minimize gear conflicts between different fisheries and determine more realistic quotas. The zoning of ocean activities such extraction of hydrocarbons, sand and gravel using seabed maps appears to be a more straightforward application.

2. What other kind of information do we need?

The use of bottom map data for ecological work and fisheries management is still in its infancy. The different scales of the available data is an issue with the bathymetry available at 5 square metre resolution while the surficial data represents an expert interpretation based upon geological sampling that may be very sparse in some areas. Biological data from the scallop surveys represents 4000 to 5000 square metres and again may be sparsely sampled in some areas. Increases in the resolution of the geological and biological information could help in increasing the precision of the linkages between seabed habitat and the distribution of benthic organisms. Currently, the bottom map information consists of bathymetry and backscatter but there may be more information that can be generated from the base data such as slope maps or the use of other visualization techniques that may present features that could be important to the animals.

3. Where else would this kind of information be useful?

This information could be useful for related activities such as the planning of surveys (trawl, trap, video) or for planning in-situ population ecology studies.

4. Are there particular information needs by the fishing industry or other users that we have missed out on?

None were identified but it was suggested that these needs may be identified once more experience has been gained with the application of bottom map data.

IV. NEXT STEPS

As part of a national seafloor mapping program NRCan has been seeking input on priority areas for future mapping in South west Nova Scotia. Extensive surveys have been completed of the offshore banks; a multiyear regional survey of the outer Bay of Fundy was being considered in partnership with the Canadian Hydrographic Service. Preliminary planning identified the full width of the Bay, east of St. John and westward to the border with the USA as a priority. Subject to funding surveys would begin in the summer of 2006 and continue for the next three years.

Research programs in DFO in support of the NRCan and CHS seafloor mapping programs have been project specific and regional in nature. Methods for accessing and analysing the seafloor mapping data have been developed as one-off applications within regions and institutes. Recently, there has been more interest by DFO researchers in using the kind of data that was generated from this project. A more national approach has been proposed for developing solutions and standards for data management, access and analysis that can be shared across the department.

APPENDIX 1: Terms of Reference

Presentation and review of Southwest Nova Scotia benthic mapping project.

In 2002, a joint project agreement (JPA) was signed with two scallop fishing fleets, Natural Resources Canada (NRCan) and Department of Fisheries and Oceans (DFO) with all parties providing funds to conduct multi-beam acoustic mapping of the seafloor and other scientific work in Scallop Fishing Area 29 off of Southwest Nova Scotia. In addition to the multibeam and geological/benthic data, projects under this JPA have also collected three years of scientific survey data, observer data, Satellite Vessel Monitoring System position data and fishermen log data.

We invite researchers, members of the fishing industry and fisheries managers who are interested in these data and their subsequent analysis to attend a presentation of the project and results to-date (Agenda attached). Presentations and subsequent discussion will be published in the DFO Canadian Science Advisory Secretariat Proceedings series.

Date:	Thursday February 16, 2006
Place:	Holiday Inn Harbourview 99 Wyse Road Dartmouth NS
TEL:	902 463-1100
Toll Free:	1-888-434-0440
Time:	9:00 am to 5 pm

Those interested in attending are asked to contact Stephen Smith at 902-426-3317 or smithsj@mar.dfo-mpo.gc.ca by January 30, 2006.

APPENDIX 3: List of Attendees (note: all area codes are 902 unless otherwise indicated.)

Name	Affiliation	Phone	Fax	Email
Michel Mitchell	DFO-Science	426-8366		mitchellma@mar.dfo-mpo.gc.ca
Terry Baker	ESFPA	889-2869		
Blair Baker	ESFPA	889-2428		
Nellie Baker Stevens	ESFPA	889-2564	889-2683	esfpa@accesswave.ca
Maureen Butler	DFO-FAM	426-9856		butlerm@mar.dfo-mpo.gc.ca
Jim Jamieson	DFO-FAM	426-8981		jamiesonje@mar.dfo-mpo.gc.ca
Stephen Smith	DFO-Science	426-3317	426-1862	smithsj@mar.dfo-mpo.gc.ca
Vlad Kostylev	NRCan-GSCA	426-8319		Vladimir.Kostylev@nrcan-rncan.gc.ca
Gerard Costello	DFO-CHS	426-3463		costellog@mar.dfo-mpo.gc.ca
Leonard Jewers	Fisherman	347-2215		
Dick Pickrill	NRCan-GSCA	426-5387	426-6186	Dick.Pickrill@nrcan-rncan.gc.ca
Jack Lowe	DFO-SWNS	742-0885	742-6835	loweja@mar.dfo-mpo.gc.ca
Mark Hartley	DFO-C&P	426-0515	426-8003	hartleym@mar.dfo-mpo.gc.ca
Sherrylynn Rowe	DFO-Science	426-8039		rowes@mar.dfo-mpo.gc.ca
Michele Covey	DFO-Science	426-7744	426-1862	coveym@mar.dfo-mpo.gc.ca
Angelica Silva	DFO-Science	426-6525	426-1862	silvaa@mar.dfo-mpo.gc.ca
Marc Ouellette	DFO-GFC	506-851-2416		ouellettemc@dfo-mpo.gc.ca
Cheryl Frail	DFO-Science	426-5448	426-1862	frailc@mar.dfo-mpo.gc.ca
Daniel Ricard	DFO-Dalhousie	426-9973		ricardd@mar.dfo-mpo.gc.ca
Denise McCullagh	DFO-OCMD	426-4274	426-3855	mcculloughd@mar.dfo-mpo.gc.ca
Dale Nicholson	DFO-CHS	426-4581	426-1893	nicholsond@mar.dfo-mpo.gc.ca
Dick MacDougall	DFO-CHS	426-3497	426-1893	macdougallr@mar.dfo-mpo.gc.ca
Scott Coffen-Smout	DFO-OCMD	426-2009	426-3855	Coffen-smouts@mar.dfo-mpo.gc.ca
Gordon Fader	NRCan (emeritus)	455-6100	426-4104	Gordon.fader@ns.sympatico.ca
Brian J. Todd	NRCan-GSCA	426-3407	426-4105	Brian.Todd@NRCan-rncan.gc.ca
Tana Worcester	DFO-Science	426-9920		worcestert@mar.dfo-mpo.gc.ca
Paul Boudreau	DFO-Habitat	426-7464		boudreaupr@mar.dfo-mpo.gc.ca
Kevin Ross	FBSA	245-4374		
Mark Lundy	DFO-Science	426-3733	426-1862	lundym@mar.dfo-mpo.gc.ca
Joy Fry	FBSA	742-9101	742-1287	aherring@ns.aliantzinc.ca
Dick Stewart	FBSA	742-9101	742-1287	aherring@ns.aliantzinc.ca
Vance Hazelton	FBSA	245-5712	245-2721	vah@ns.sympatico.ca
Brian Longmire	FBSA	532-5634	532-5249	b.m.longmire@ns.sympatico.ca

Name	Affiliation	Phone	Fax	Email
Brian Giroux	West 65°30′	742-6732		sfmobile@ns.sympatico.ca
John Tremblay	DFO-Science	426-3926	426-1862	tremblayj@mar.dfo-mpo.gc.ca
Bob Branton	DFO-Science	426-3537		brantonb@mar.dfo-mpo.gc.ca
Jerry Black	DFO-Science	426-2950		blackj@mar.dfo-mpo.gc.ca
Alida Bundy	DFO-Science	426-8353		bundya@mar.dfo-mpo.gc.ca
Anne Harrington	DFO-SWNB	506-529-5871	506-529-5858	harringtona@mar.dfo-mpo.gc.ca
Ellen Kenchington	DFO-Science	426-2030		kenchingtone@mar.dfo-mpo.gc.ca
Trevor Kenchington	Gadus Assoc.	889-9250		gadus@istar.ca
Douglas Pezzack	DFO-Science	426-2094		pezzackd@mar.dfo-mpo.gc.ca
Peter Hurley	DFO-Science	426-3520		hurleyp@mar.dfo-mpo.gc.ca

DFO=Dept. Fisheries and Oceans; ESFPA=Eastern Shore Fishermen's Protection Association; FAM=Fisheries and Aquaculture Management; NRCan=Natural Resources Canada; GSCA=Geoscience Canada Atlantic; CHS=Canadian Hydrographic Service; SWNS=Southwest Nova Scotia (Area); C&P=Conservation and Protection Branch; GFC=Gulf Fisheries Centre; OCMD= Oceans and Coastal Management Division; Habitat=Habitat Management Division; FBSA=Full Bay Scallop Association; West 65°30′= West 65°30′ scallop quota representative; SWNB=Southwest New Brunswick (Area).